


Evaluation of Comprehensive GHG Emissions Reduction Programs Outside of Washington – Final Report

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Prepared for:
State of Washington
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Acronyms

AB	Assembly Bill
ACEEE	American Council for an Energy-Efficient Economy
ACP	Alternative Compliance Payments
ACSE	American Society of Civil Engineers
AEO	EIA's Annual Energy Outlook
AFV	Alternative-Fuel Vehicle
ANREU	Australian National Registry of Emissions Units
APR	Annual Percentage Rate
APTA	American Public Transportation Association
ARB	California Air Resources Board
ARFVTP	Alternative and Renewable Fuel and Vehicle Technology Program
ARRA	American Recovery and Reinvestment Act
B&O	Business and Occupation
BAU	Business-as-Usual
BC	British Columbia
BCG	Boston Consulting Group
BEV	Battery Electric Vehicle
BHI	Beacon Hill Institute
BOEM	Bureau of Ocean Energy Management
BPU	New Jersey Board of Public Utilities
Btu	British Thermal Units
C&T	Cap and Trade
CAD	Canadian Dollar
CalEPA	California Environmental Protection Agency
CAT	Washington State Climate Action Team
CBO	Congressional Budget Office
CCCT	Combined-Cycle Combustion Turbine
CCEF	Connecticut Clean Energy Fund
CCR	Cost Containment Reserve
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CEC	California Energy Commission
CEEF	Connecticut Energy Efficiency Fund
CEFIA	Connecticut Clean Energy Finance and Investment Authority
CELC	Washington Clean Energy Leadership Council
CEP	Washington Clean Energy Partnership
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CETIP	Oregon Commercial Electric Truck Incentive Program
CFI	Carbon Farming Initiative

CGE	Computable General Equilibrium
CH₄	Methane
CHP	Combined Heat and Power
CI	Carbon Intensity
CLEW	Climate Legislative Executive Workgroup
CMAQ	Congestion Mitigation and Air Quality
CMSP	Coastal and Marine Spatial Planning
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO₂	Carbon Dioxide
CO₂e	Carbon Dioxide Equivalent
CPI	Consumer Price Index
CPM	Carbon Pricing Mechanism
CPUC	California Public Utilities Commission
CSI	California Solar Initiative
CSLP	ClimateSmart Loan Program
CTT	Clean Transportation Triangle
CVRP	California Clean Vehicle Rebate Project
DCEO	Illinois Department of Commerce and Economic Opportunity
DOE	U.S. Department of Energy
DPM	Diesel Particulate Matter
EDF	Environmental Defense Fund
EE	Energy Efficiency
EEG	Erneuerbare-Energien-Gesetz
EER	Energy Economy Ratio
EERE	U.S. DOE Office of Energy Efficiency and Renewable Energy
EIA	U.S. DOE Energy Information Administration
EISA	Energy Independence and Security
EMT	Economic Modeling Team
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPIC	Electric Program Investment Charge
ETS	Emissions Trading Scheme
EU	European Union
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FCM	ISO New England Forward Capacity Market
FCV	Fuel Cell Vehicles
FERC	Federal Energy Regulatory Commission
FHFA	Federal Housing Finance Agency

FHWA	Federal Highway Administration
FIT	Feed-in Tariff
FTE	Full Time Employee
FY	Fiscal Year
GCCS	Gas Collection and Control System
gCO₂e/MJ	Grams of carbon dioxide equivalent per mega joule
GDP	Gross Domestic Product
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse Gas
GWh	Gigawatt hour
HFCs	Hydrofluorocarbons
HINMREC	Hawaii National Marine Renewable Energy Center
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
HTF	Federal Highway Trust Fund
ILUC	Indirect Land Use Change
IOU	Investor-Owned Utilities
IPCC	Intergovernmental Panel on Climate Change
JCP	Jobs and Competitiveness Program
JI	Joint Implementation
kWh	Kilowatt hour
LCA	Life Cycle Associates, LLC
LCFS	Low Carbon Fuel Standard
LFG	Landfill Gas
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MACC	Marginal Abatement Cost Curve
Mg	Megagrams
MHK	Marine and Hydrokinetic
MJ	Megajoule
mmBtu	One Million British Thermal Units
MMTCO₂e	Million Metric Tons Carbon Dioxide Equivalent
MOU	Memorandum of Understanding
MPG	Miles Per Gallon
MPO	Metropolitan Planning Organization
MPR	Market Price Referent
MSW	Municipal Solid Waste
mtCO₂e	Metric Tons Carbon Dioxide Equivalent
MW	Megawatt
MWh	Megawatt hour

NAICS	North American Industry Classification System
NEMS	National Energy Modeling System
NJCEP	New Jersey's Clean Energy Program
NMOC	Non-Methane Organic Compounds
NNMREC	Northwest National Marine Renewable Energy Center
NOAA	National Oceanographic and Atmospheric Administration
NOx	Nitrogen Oxides
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
NSPS	New Source Performance Standards
NYSERDA	New York State Energy Research and Development Authority
NZ ETS	New Zealand Emissions Trading Scheme
NZIER	New Zealand Institute of Economic Research
NZU	New Zealand Units
O&M	Operations and Maintenance
ODOT	Oregon Department of Transportation
ODS	Ozone-Depleting Substance
OFM	Office of Financial Management
OGV	Ocean Going Vessels
OPA	Ontario Power Authority
PACE	Property Assessed Clean Energy
PACT	Program Administrator Cost Test
PAYD	Pay-as-you-Drive
PBF	Public Benefits Fund
PCT	Participant Cost Test
PEEBA	Procurement Energy Efficiency Balancing Account
PEV	Plug-in Electric Vehicle
PFCs	Perfluorocarbons
PGC	Public Goods Charge
PHEV	Plug-In Hybrid Electric Vehicle
PIER	California Public Interest Energy Research
POLA	Port of Los Angeles
POLB	Port of Long Beach
PPA	Purchased Power Agreement
PPC	Public Purpose Charge
PSCAA	Puget Sound Clean Air Agency
PUB	Public Utility District
PV	Photovoltaic
PZEV	Partial Zero Emission Vehicle
R&D	Research and Development
RAC	Remediation Adjustment Clause

RBNZ	Reserve Bank of New Zealand
RCI	Residential, Commercial, and Industrial
RD&D	Research, Development and Demonstration
RE	Renewable Energy
REFSSA	Renewable Energy Facility Site Suitability Area
ReMAT	Renewable Market Adjusting Tariff
RFID	Radio Frequency Identification
RFS	Renewable Fuels Standard
RGGI	Regional Greenhouse Gas Initiative
RIN	Renewable Identification Numbers
RPS	Renewable Portfolio Standards
RVO	Renewable Volume Obligation
SAIC	Science Applications International Corporation
SBC	System Benefits Charge
SCAQMD	South Coast Air Quality Management District
SCEIP	Sonoma County Energy Independence Program
SEK	Swedish Krona
SF₆	Sulfur Hexafluoride
SNMREC	Southeast National Marine Renewable Energy Center
SO₂	Sulfur Dioxide
SO_x	Sulfur Oxides
STAMP	State Tax Analysis Modeling Program
STIP	State Transportation Improvement Plan
T&MD	Technology and Market Development
TERP	Texas Emissions Reduction Plan
TOTE	Totem Ocean Trailer Express, Inc.
TRC	Total Resource Cost
TTW	Tank-to-Wheel
TWh	Terawatt hour
TZEV	Transitional Zero Emissions Vehicle
U.K.	United Kingdom
U.S.	United States
USDA	U.S. Department of Agriculture
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
WA	Washington
WCGA	West Coast Governors Alliance
WCI	Western Climate Initiative
WSDA	Washington State Department of Agriculture
WSF	Washington State Ferry

WSPA	Western States Petroleum Association
WSTC	Washington State Transportation Commission
WTT	Well-to-Tank
WTW	Well-to-Wheel
WWPTO	Wind and Water Power Technologies Office
ZEV	Zero Emissions Vehicle

DRAFT

1 Introduction

The Climate Legislative and Executive Workgroup (CLEW), as part of its Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State, has tasked Science Applications International Corporation (SAIC) through the Office of Financial Management (OFM) with identifying and evaluating comprehensive greenhouse gas (GHG) emission reduction programs in the Pacific Northwest, on the West Coast, in neighboring provinces in Canada, in other region of the U.S. and in other countries. SAIC identified and evaluated the costs and benefits of programs based on the potential of each to contribute to meeting the state's greenhouse gas (GHG) emission targets for 2020, 2035, and 2050.

On September 9 2013, SAIC submitted a draft document in fulfillment of those objectives, and received comments from the State on Friday September 13, 2013. This document provides additional response to further comments provided by the State and provides new cost effectiveness data.

This report examines potential GHG reduction policies implemented in other jurisdictions, and considers their applicability to Washington. Policies and programs targeting reductions in GHG emissions abound, and countless other policies have GHG reductions as a secondary or tertiary effect. In total, these programs are far too numerous to consider in any depth as Washington evaluates potential policies to complement its existing GHG reduction efforts. The goal of this effort is to analyze a sub-set of GHG emission reduction policies that have been implemented in other jurisdictions in order to understand their potential to contribute to Washington's GHG emission reduction goals. In addition to achieving real and significant GHG reductions, these policies would ideally shift energy production from out-of-state to in-state sources, reduce reliance on fossil fuels, and have positive impacts on job creation and infrastructure development, while minimizing any adverse impacts on household income.

Two broad categories of policies are presented: comprehensive economy-wide efforts and sector-specific or technology-specific programs. The coverage of GHG emissions regulated in comprehensive carbon pricing programs can involve virtually the entire economy of the host jurisdiction. However, these programs vary in how pricing is imposed, in some cases constraining the quantity of emissions under a cap and trade regime, and in others directly setting the price of GHG emissions with a carbon tax. Sector-specific or technology-specific programs target discrete sources of emissions, or activities that drive emissions, and can together form a portfolio that is comprehensive. These policies may target electricity generation, transportation fuels, or any other GHG-intensive sector of the economy. A list of policies that are reviewed in this report is provided in Table 1. A more detailed review of the implementation history of each policy is provided in Appendix A.

For each of the reviewed policies, this report summarizes various attributes and implementation issues, examines potential costs and benefits to Washington consumers and businesses, and reviews existing literature on the potential for the policy in Washington. For those policies with an orange check mark, original analysis of the GHG emission reduction potential was conducted. The quantification methodologies are summarized in each respective section.

Those policies with a purple check mark have also been researched and are summarized in this report, but were not subjected to original quantification. Some of these were not quantified in detail due to difficulty projecting them as a single policy as opposed to a portfolio of related policies implemented in coordination. Ultimately, the lack of original quantification is a function of resource constraints and dedicating energy towards those policies for which quantification was expected to be most useful to decision-makers. Some of the non-quantified policies, for example those related to public transit and road pricing, are already the subject of considerable energies through existing state efforts and a breadth of other resources to supplement this work exists.

Table 1. Policies with potential GHG emission reduction benefits assessed.

Economy-wide GHG Reduction Policies	
✓	Cap and Trade
✓	Carbon Tax
Transportation and Land Use Policies	
✓	Low Carbon Fuel Standard
✓	Zero Emissions Vehicle Mandate
✓	Renewable Fuel Standard and Biofuel Support
✓	Pricing Policies
✓	Investment in Public Transit
Energy Conservation Policies	
✓	Public Benefit Fund
✓	Property Assessed Clean Energy
✓	Marine Fuel Conservation
Renewable Energy Policies	
✓	Feed-in-Tariff
✓	Offshore Wind and Ocean Power
Waste Sector Policies	
✓	Landfill Methane Capture
Agriculture and Forestry	
✓	See Appendix ¹
✓	Reviewed, and GHG reductions quantified
✓	Reviewed, but not quantified

¹ Washington's 2008 Climate Action Team

There is also activity proposed and ongoing within and beyond the Washington State government to better understand the air emissions, health and climate change impacts of out-of-state coal transported by rail to Washington export terminals for subsequent consumption overseas.² Coal, or other fossil exports such as liquefied natural gas (LNG), and associated GHG emissions were not analyzed under the scope of this task, although a discussion of increased LNG exports is provided in the Task 3 Final Report on Evaluation of Federal Policies.

² The WA Dept. of Ecology is Washington reviews proposals and permits for coal export project proposals through the Environmental Impact Statement process. Ecology's website provides more detailed information, at http://www.ecy.wa.gov/news/2012/itn03_coal.html

2 Summary Findings

Research conducted for this effort identified myriad policies and programs with the potential to reduce emissions in Washington. This section provides an overview of findings from this research on policies summarized in the sections that follow. More detailed information on these policies can be found in Sections 4 through 15 of this report. A thorough literature review of the implementation of each policy in various jurisdictions is provided as Appendix A.

Table 2 provides a high-level overview of the policies discussed in this report. The magnitude of potential reductions and impacts on the economy, expenditures, and job creation will be highly dependent on the aggressiveness of the policy design and funding levels. As these design specifications are uncertain – and will be the subject of CLEW deliberations – Table 2 is intended to provide an order of magnitude or directional indication of the impacts of the policies to assist in understanding their qualitative impacts.

Table 2. Qualitative summary of potential GHG reduction policies

Policy	Magnitude of Potential Emissions Reductions	Net Economy-Wide Financial Impact on Washington Consumers and Businesses	Opportunity to Increase in-state energy production and expenditures	Opportunity for new infrastructure and jobs in clean tech and energy efficiency
Cap and Trade	High	Uncertain ^a	Medium	Medium ^b
Carbon Tax	High	Uncertain ^a	Medium	Medium ^b
Low Carbon Fuel Standard	High	Uncertain	High	High
Zero Emissions Vehicle Mandate	Medium	Uncertain ³	Medium	High
Renewable Fuel Standard	Medium	Uncertain ⁴	Medium	Medium
Transportation Pricing – Mileage User Fee ⁵	Low	Uncertain	Low	Low

³ ZEV requires significant state and individual investment. However, ZEVs provide a payback to consumers over time based on cheaper per-mile equivalent price of electricity relative to gasoline.

⁴ Recent State data show that biodiesel unit cost is less than conventional diesel, however there are implementation costs and potential availability issues may have cost implications.

⁵ GHG and economic impacts of MBUF policy greatly depend on design and implementation as a GHG strategy. It would presumably create the much needed revenue for transportation infrastructure as a gas-tax replacement.

Policy	Magnitude of Potential Emissions Reductions	Net Economy-Wide Financial Impact on Washington Consumers and Businesses	Opportunity to Increase in-state energy production and expenditures	Opportunity for new infrastructure and jobs in clean tech and energy efficiency
Investment in Public Transit	Low	Uncertain ⁶	Low	High
Public Benefit Fund	Medium	Positive	High	High
Property Assessed Clean Energy	Low	Positive	High	High
Marine Fuel Conservation	Low	Positive	Medium	Medium
Feed-in-Tariff	Low	Negative	High	Medium
Offshore Wind and Ocean Power	Medium	Uncertain	High	High
Landfill Methane Capture	Low	Negative	Medium	Low

^a The financial impact to consumers and businesses is dependent on how the revenues were used, and highly dependent upon revenue utilization

^b RGGI program has demonstrated real result by applying revenues to enhance opportunity for new jobs and infrastructure in clean tech and efficiency

Understanding the cost effectiveness of emissions reductions measures is an important factor in making decisions on policy implementation. Table 3 presents a comparison of the cost per metric ton of carbon dioxide equivalent (mtCO₂e) of various emissions reductions measures that researchers analyzed for Washington, the entire United States, and California. The purpose of this table is to exemplify how some of the policy options analyzed in this report can result in cost effective emissions reductions measures. These data come from five reports including the Washington Climate Advisory⁷ analysis and four nationally recognized marginal abatement cost curves (MACC) authored by researchers at McKinsey⁸, Bloomberg⁹, Johns Hopkins

⁶ Major investments would increase service and lower fares, which would have a positive impact on riders; however increased subsidies would likely require raising taxes, which would negatively impact tax payers.

⁷ Washington Climate Advisory Team. 2008. Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State. 72pp. Online at: <https://fortress.wa.gov/ecy/publications/publications/0801008b.pdf>

⁸ Creyts, J., Derkach, A., Nyquist, S., Ostrowski, K., and J. Stephenson. 2007. Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? U.S. Green House Gas Abatement Mapping Initiative Executive Report. 107pp. Online at: http://www.mckinsey.com/client_service/sustainability/latest_thinking/reducing_us_greenhouse_gas_emissions

University¹⁰, and Stanford University¹¹. Ranges are provided representing the high- and low-cost estimates in the literature, with intermediate results omitted for simplicity. Although not all numbers are Washington-specific, and methodologies and assumptions vary by study, these data paint a picture of the potential costs of certain emissions reduction measures under the policies analyzed here.

Table 3. Cost effectiveness (2010 dollars per metric ton of CO₂e) comparison of emissions reduction measures taken from nationally-recognized MACCs. Parentheses indicate negative numbers that should be interpreted as cost savings.

Policy Category	Emissions Reduction Measure	Cost Effectiveness (\$2010/mtCO ₂ e)
Transportation	Low Carbon Fuel Standard	\$25 ^c to \$129 ^a
	ZEV Goal	\$266 ^a
	Production of Biofuels and feedstocks (RFS and AFVs)	(\$20) ^b to \$63 ^a
	Vehicle Incentives (EV, AFV, or both)	(\$70) ^d to \$411 ^a
	Diesel Engine Emissions Reductions, Fuel Efficiency, and medium to heavy duty truck hybridization (AFV Incentives)	(\$69) ^d to \$74 ^c
	Transportation Pricing	No Data
	Public Transit	\$18 ^d
	Shore Electrification	\$61 ^c
Energy Conservation (funded by PBF or PACE)	Financial Incentives and Instruments/Demand Side Management Programs	(\$43) ^d
	Improvements to Existing Buildings with Emphasis on Building Operations	(\$80) ^e to \$7 ^b
	Lighting	(\$97) ^b to \$51 ^c
	Electronic Equipment	(\$103) ^b
	HVAC Equipment	\$5 ^c to \$50 ^b
	Building Shell	(\$47) ^b to \$21 ^c
	Residential Water Heaters	\$9 ^b

⁹ Bloomberg New Energy Finance. 2010. A Fresh Look at the Costs of Reducing US Carbon Emissions. 33pp. Online at: <http://about.bnef.com/white-papers/us-mac-curve-a-fresh-look-at-the-costs-of-reducing-us-carbon-emissions/>

¹⁰ Johns Hopkins University and The Center for Climate Strategies. 2010. Impacts of Comprehensive Climate and Energy Policy Options on the U.S. Economy. 76pp. Online at: <http://www.climatestrategies.us/library/library/download/105>

¹¹ Sweeney J., and J. Weyant. 2008. Analysis of Measures to Meet the Requirements of California's Assembly Bill 32 (DRAFT September 27, 2008). Precourt Institute of Energy Efficiency, Stanford University. 108pp.

Renewable Energy Generation (funded by PBF or PACE, or incentivized by FIT)	Conversion Efficiency	(\$17) ^b
	Distributed Renewable Energy Incentives	\$146 ^a
	Wind	\$22 ^b to \$114 ^e
	Solar Photovoltaic	\$32 ^b to \$51 ^c
	Solar Thermal	\$134 ^e to \$142 ^c
	Geothermal	(\$15) ^c to \$102 ^e
	Small Hydropower	\$100 ^c
	CHP	(\$40) ^b to \$20 ^e

^a = Washington CAT

^b = McKinsey

^c = Bloomberg

^d = Johns Hopkins

^e = Sweeney and Weyant

To tailor results more specifically to Washington, this report performed original analysis and calculations on a sub-set of promising policies to understand the emissions reduction opportunities and costs in Washington. Table 4 summarizes this analysis for the eight policies for which quantification was performed. These estimates are the results of specific policy assumptions documented in each policy's respective section. Changing the assumptions, for example the magnitude of a carbon tax, stringency of the cap, or investment in a PACE program, will change the estimated emissions reductions. Therefore, these should be considered as estimates within the context of the assumptions documented in later chapters. Tailored calculations can be conducted based on specified inputs.

Table 4. Estimated GHG emission reduction potential of policies when independently implemented. Interactions may decrease emissions when policies are implemented together.

Policy	GHG Reductions (MMTCO ₂ e)			Cost effectiveness (\$/mtCO ₂ e) ^a	Source of Emissions Addressed
	2020	2035	2050		
Cap and Trade	12.1	22.1	35.9	Not quantified	Electricity, RCI, Transportation
Carbon Tax	0.4 – 1.7	0.6 – 5.0	Not quantified	\$5 to \$23	Electricity, RCI, Transportation
Low Carbon Fuel Standard	1.0	3.9	4.0	\$103 to \$131	Transportation
Zero Emissions Vehicle Mandate	0.1	2.0	2.6	\$(70) to \$70	Transportation
5% Renewable Fuel Standard ^b	0.2	0.4	0.4	Not quantified	Transportation
Public Benefit Fund ^c	0.6	2.9	Not quantified	\$(103) to \$146	Electricity, RCI

Property Assessed Clean Energy ^d	0.02	0.05	0.6	\$(171)	Electricity, RCI
Feed-in-Tariff, 375 MW Cap ^e	0.5	0.5	0.5	\$30 to \$500	Electricity

^a NPV 2013 of emission reductions through 2035, 5 percent discount rate

^b Represents the net gain in emission reductions of a 5 percent RFS relative to Washington's current 0.5 percent RFS attainment

^c Assumes extending I-937 utility requirements to utilities under 25,000 customers. Two additional options were considered in the analysis as well. Results are highly dependent on funding levels.

^d Based on assumed PACE funding of \$50 million over 5 years. Results are scalable.

^e All Feed-in-Tariff reductions would contribute to I-937 goals.

The estimates in Table 4 assume that each policy would be implemented independently from all of the others. However, if multiple policies were implemented either simultaneously or in succession, there would likely be significant interactions that would decrease the overall quantity of emissions reductions achieved. Quantitatively estimating that interaction in conjunction with existing Washington policies and federal policies will be performed in the Task 4 report for this effort. Table 5 provides a qualitative summary of the interactions that would be expected between policies. Three types of interactions are indicated.

- **Complement:** indicates that the emissions reductions of the policy occur in a capped sector and will contribute to meeting a cap. These policies do not reduce the total amount of emissions reductions required within the capped sector, but the portion of reductions that must be achieved via the cap and trade mechanism is diminished by the portion achieved by the complementary policy
- **Partial diminishment:** occurs when two policies target the same source of emissions for reductions, or when emission reductions in one sector reduce the efficacy of a strategy in another.
- **No significant interaction:** there is no expected interaction that would decrease the overall quantity of emissions reductions achieved.

Table 5. Qualitative summary of interactions between seven policies evaluated in greatest depth. Table can be read vertically or horizontally, as entries to the right of grey cells are the same as those to the left.

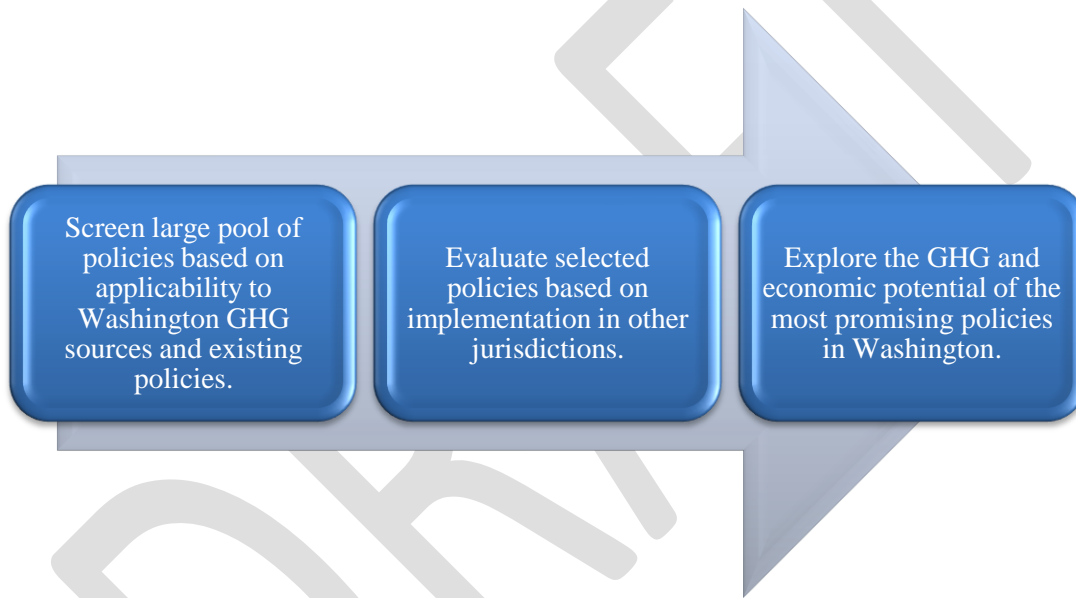
	Cap and Trade	Carbon Tax	LCFS	ZEV Mandate	PBF	PACE Programs	Feed-in-Tariff
Cap and Trade (C&T)	N/A	Partial diminishment: cap and trade and carbon tax are both economy-wide strategies	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Complement: policy will reduce capped sector emissions, contributing to meeting C&T
Carbon Tax	Partial diminishment: cap and trade and carbon tax are both economy-wide strategies	N/A	Partial diminishment: carbon tax and LCFS both target transportation fuels	Partial diminishment: carbon tax and ZEV Mandate both target transportation emissions	Partial diminishment: carbon tax and PBF both encourage renewables and energy efficiency	Partial diminishment: carbon tax and PACE both encourage renewables and energy efficiency	Partial diminishment: carbon tax and FIT both encourage renewables
Low Carbon Fuel Standard (LCFS)	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Partial diminishment: carbon tax and LCFS both target transportation fuels	N/A	Partial diminishment: ZEV Mandate and LCFS target vehicles and transportation fuels, respectively	No significant interaction	No significant interaction	No significant interaction
Zero Emissions Vehicles (ZEV) Mandate	Complement: policy will reduce capped sector emissions, contributing to	Partial diminishment: carbon tax and ZEV Mandate both target transportation	Partial diminishment: ZEV Mandate and LCFS target vehicles and	N/A	No significant interaction	No significant interaction	No significant interaction

	Cap and Trade	Carbon Tax	LCFS	ZEV Mandate	PBF	PACE Programs	Feed-in-Tariff
	meeting C&T	emissions	transportation fuels, respectively				
Public Benefit Fund (PBF)	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Partial diminishment: carbon tax and PBF both encourage renewables and energy efficiency	No significant interaction	No significant interaction	N/A	Partial diminishment: PBF and PACE may target same emission reductions. Both subsumed by I-937	Partial diminishment: PBF and FIT may target same emission reductions. Both subsumed by I-937
Property Assessed Clean Energy (PACE) Programs	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Partial diminishment: carbon tax and PACE both encourage renewables and energy efficiency	No significant interaction	No significant interaction	Partial diminishment: PBF and PACE may target same emission reductions. Both subsumed by I-937	N/A	Partial diminishment: PACE and FIT may target same emission reductions Both subsumed by I-937
Feed-in-Tariff	Complement: policy will reduce capped sector emissions, contributing to meeting C&T	Partial diminishment: carbon tax and FIT both encourage renewables	No significant interaction	No significant interaction	Partial diminishment: PBF and FIT may target same emission reductions. Both subsumed by I-937	Partial diminishment: PACE and FIT may target same emission reductions. Both subsumed by I-937	N/A

3 Policy Screening and Evaluation Process Overview

Virtually unlimited policies exist that either directly or indirectly, positively or negatively, intentionally or unintentionally, impact GHG emissions. It is neither feasible nor beneficial to evaluate all of these policies. It is not feasible due to the budget and scope of this effort; it is not beneficial because it would dilute the attention focused on the policies of greatest potential. Therefore, this effort applied an iterative screening process to identify the programs with greatest potential as GHG mitigation policies. A graphical representation and summary is provided in Figure 1.

Figure 1. Policy screening and evaluation process



To begin the policy screening and evaluation process, various types of policies were qualitatively considered in the context of Washington’s GHG emission profile and major sources. From a pool of virtually limitless policies with the potential to affect GHG emissions, a list of approximately 20 policies was established for further analysis.

Potential targeted programs were identified through several channels. First, policies and sectors recommended by members of the Washington State Climate Legislative and Executive Workgroup (CLEW) were considered to ensure that topics of interest to Washington State stakeholders were studied. Second, the breakdown of emissions in Washington State’s 2010 GHG inventory were reviewed, and all sources were considered on the combined basis of their magnitude in 2010, and their growth since 1990, as shown in Table 6. For these flagged sources, Washington State’s actions to date and initiatives taken in other states and local governments targeting reductions in emissions from these sources were reviewed. Broadly, three categories of

emissions dominate Washington's profile, have grown considerably from 1990 levels, and provide the greatest opportunity for reductions:

- Transportation
- Electricity
- Residential, commercial, and industrial sector (RCI)

Industrial processes, waste, and agriculture also contribute to Washington's GHG emissions. The agricultural sector is the most significant of these, but is not included for further analysis because of its diverse emission sources, the complexity of managing livestock and soil emissions, and the potential for impacting productivity. Additionally, emissions from agriculture have fallen from 1990 levels. Finally, although emissions from the waste sector have grown from 1990 to 2010, in absolute terms they are still relatively small. Table 6 summarizes Washington State's GHG emissions profile in 2010.

Table 6: Washington State 2010 GHG Inventory

Million Metric Tons CO ₂ e	1990 ¹²	2005	2010	2010 (%)	Change from 1990 Levels
Electricity, Net Consumption-based	16.9	18.8	20.7	22%	22%
Coal	16.8	15.2	15.8	17%	-6%
Natural Gas	0.1	3.6	4.8	5%	47%
Petroleum	0.0	0.0	0.1	0%	>100%
Biomass and Waste (CH ₄ and N ₂ O)	0.0	0.0	0.0	0%	-
Residential/Commercial/Industrial (RCI)	18.6	19.3	19.7	21%	6%
Coal	0.6	0.1	0.3	0%	-50%
Natural Gas	8.6	10.3	10.8	11%	26%
Oil	9.1	8.7	8.4	9%	-8%
Wood (CH ₄ and N ₂ O)	0.2	0.2	0.2	0%	0%
Transportation	37.5	44	42.2	44%	13%
Onroad Gasoline	20.4	23.9	21.9	23%	7%
Onroad Diesel	4.1	7.1	8.0	8%	95%
Marine Vessels	2.6	3.3	3.0	3%	15%
Jet Fuel and Aviation Gasoline	9.1	7.7	8.1	9%	-11%
Rail	0.8	1.3	0.5	1%	-38%
Natural Gas, LPG	0.6	0.7	0.7	1%	17%

¹² Washington State Department of Ecology. 2007. Washington State 1990 Greenhouse Gas Emissions Inventory. Accessed September 2013 at: www.ecy.wa.gov/climatechange/docs/1990GHGBaseline_Legislators.pdf

Million Metric Tons CO ₂ e	1990 ¹²	2005	2010	2010 (%)	Change from 1990 Levels
Fossil Fuel Industry	0.5	0.8	0.7	1%	40%
Natural Gas Industry(CH ₄)	0.4	0.7	0.7	1%	75%
Coal Mining (CH ₄)	0.0	0.1	0.0	0%	-
Oil Industry (CH ₄)	0.0	0.0	0.0	0%	-
Industrial Processes	7	3.8	3.8	4%	-46%
Cement Manufacture (CO ₂)	0.2	0.4	0.3	0%	50%
Aluminum Production (CO ₂ , PFCs)	5.9	0.8	0.5	1%	-92%
Limestone and Dolomite Use (CO ₂)	0.0	0.0	0.0	0%	-
Soda Ash	0.1	0.1	0.1	0%	0%
ODS Substitutes (HFCs, PFCs and SF ₆)	0.0	2.1	2.5	3%	-
Semiconductor Manufacturing (HFCs, PFCs, SF ₆)	0.0	0.1	0.1	0%	>100%
Electric Power T&D (SF ₆)	0.8	0.3	0.3	0%	-63%
Waste Management	1.5	2.5	2.8	3%	87%
Solid Waste Management	1.0	1.9	2.1	2%	>100%
Wastewater Management	0.5	0.6	0.7	1%	40%
Agriculture	6.4	5.7	5.2	5%	-19%
Enteric Fermentation	2.0	2.1	2	2%	0%
Manure Management	0.7	1.1	1.1	1%	57%
Agriculture Soils	3.7	2.5	2.1	2%	-43%
Total Gross Emissions	88.4	94.9	95.1	100%	8%

The initial list of policies was further refined based on additional research and feedback from the CLEW. Next, each remaining policy was evaluated in greater depth to understand their successes and lessons learned in jurisdictions where they have been implemented, across a variety of metrics including cost, impact on fuel choice and consumption, household and economic impacts, and co-benefits. A literature review was conducted on each policy for a selection of implementation instances (i.e., jurisdictions that have already instituted that policy). To the extent permitted by the available resources, the following issues were addressed:

- Quantity of GHG emissions reductions achieved
- Cost of GHG emissions reductions, or costs associated with the program
- Potential to cause GHG or economic leakage, shifting emissions or economic activity out-of-state
- The effectiveness of the program in helping the jurisdiction achieve its emissions reduction goals, including cost per ton of emissions reduction

- The relative impact upon different sectors of the jurisdiction's economy, including power rates, agriculture, manufacturing, and transportation fuel costs
- The effect on household consumption and spending, including fuel, food, and housing costs, and program measures to mitigate to low-income populations
- Displacement of emission sources from the jurisdiction due to the program
- Any significant co-benefits to the jurisdiction, such as reduction of potential adverse effects to public health, from implementing the program
- Opportunities for new manufacturing infrastructure, investments in cleaner energy and energy efficiency, and jobs including in-state opportunities
- Achievements in greater independence from fossil fuels and the economic costs and benefits
- Impacts on fuel choice

Results from this research are provided in Appendix A.

Based on additional feedback from the CLEW, the implementation history reviewed, and a set of screening criteria, the most promising policies were selected and reviewed using exiting literature exploring their potential costs and benefits in Washington, including impact on consumers and businesses, and potential to generate infrastructure investment and create jobs. In addition to those noted already, the primary screening criteria and their justification are shown in Table 7.

Table 7: Primary Screening Criteria for Promising Policies in Washington State

Screening Criteria	Justification
Does the policy target an emissions source of significant magnitude in Washington?	Policies targeting small sources of emissions will not generate the magnitude of reductions that Washington requires.
What have been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?	Policies that have not succeeded or have not generated significant reductions in other jurisdictions are unlikely to succeed in Washington, unless there are noteworthy differences between the jurisdictions.
Is the policy discrete and comprehensive, or is it instead a bundle of related policies?	Comprehensive policies will generate more extensive GHG reductions, and do not require a multitude of individual policies targeting the same source. This reduces the number of policies on which CLEW must engage.
Can the policy be meaningfully implemented or influenced at the state level?	Some policies are best implemented and administered at the federal or local level. The goal of this exercise is to identify policies that the CLEW can pursue and implement for the State.

Finally, tailored analyses of GHG reduction potential and investment potential in Washington are provided for the eight policies described in the Introduction.

4 Cap and Trade

Table 8: Potential Costs and Benefits of a Cap and Trade System to Washington Consumers and Businesses

Potential Action for Consideration			
<ul style="list-style-type: none">Implement an economy-wide cap and trade program covering emissions from electricity, transportation fuels, and residential, commercial and industrial sectors.			
GHGs and Costs in Washington	2020	2035	2050
GHG Emissions Cap (MMTCO ₂ e)	70.6	53.0	35.3
GHG Reductions from Cap (MMTCO ₂ e)	12.1	22.1	35.9
Value of Allowance Commodity at \$30/ton (billion \$)	\$2.3	\$1.6	\$1.1
Implementation Issues and Lessons Learned			
<ul style="list-style-type: none">Although the quantity of emissions is known under cap and trade, it is difficult to forecast and impossible to know in advance the actual costs of compliance.The emissions cap must be set appropriately to avoid market over-supply, leading to low prices and insufficient market signal for innovation, or under-supply leading to high prices and negative economic impacts. Historically, markets including the EU ETS and RGGI have suffered from over-allocation due to events such as the economic recession and the drop in natural gas prices. California has not had an over-allocation issue thus far, though current signs suggest a long market through 2020.Allowances convey a valuable property right; they can be freely allocated, auctioned, or distributed through a combination of mechanisms.Cost containment mechanisms such as offsets, price caps, and free allocation can be used to protect the market from unacceptably high costs or distributional inequities.Some sectors face greater trade exposure and leakage risk than others. These sectors can be protected through free allocation of allowances or exemptions.Revenue generated by the State can be invested based on State priorities. Safeguards to ensure borrowing of revenue, as occurred in California, can protect these funds.			
Potential Costs and Benefits to WA Consumers		Potential Costs and Benefits to WA Businesses	
<ul style="list-style-type: none">There is no consensus among studies as to whether cap and trade would increase or decrease personal income.Some studies suggest that cap and trade will result in significant net savings; others suggest that it will diminish disposable income.		<ul style="list-style-type: none">Regulated industries will face increased costs of compliance; however, many of these costs can be passed to customers.With sufficient scarcity, cap and trade should foster innovation and support clean tech.	
Summary of Screening Criteria			
<p><i>Does the policy target an emissions source of significant magnitude in Washington?</i></p> <p>Cap and trade could cover emissions from the electricity, residential, commercial, and industrial, and transportation sectors, which comprise over 90 percent of Washington GHG emissions.</p>			
<p><i>What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?</i></p> <p>The EU ETS and RGGI cap and trade programs have both achieved GHG reduction goals. However, it is unclear what portion of these GHG reductions are attributable to cap and trade, and what portion is attributable to the economic downturn. Both programs have suffered from over-supply of allowances and low costs, which diminish the incentive for innovation.</p>			

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

Cap and trade is a comprehensive policy that can be implemented economy-wide.

Can the policy be meaningfully implemented or influenced at the State level?

Cap and trade would ideally be implemented on as large a scale as possible. Some critics argue that implementation at the State level may lead to leakage and diminished effectiveness, and suggest that it should be implemented only at the federal or international level. However, jurisdictions including California and Quebec have implemented state/provincial programs and begun linking to create a larger, more economically efficient cap and trade system, demonstrating a leadership role.

4.1 Introduction

A cap and trade program is a market-based mechanism used to achieve reductions in the emissions of a particular pollutant or group of pollutants (in this case, greenhouse gases). Conceived largely as an alternative to address concerns raised by traditional command-and-control environmental regulation, cap and trade does not prescribe the methods that firms must use to reduce emissions, nor does it dictate the ultimate level of emissions for any individual firm. Instead, cap and trade sets an overall cap on emissions for a geographic boundary, or an individual sector, or group of sectors within that boundary and requires companies to hold rights (typically referred to as allowances) for any emissions that fall under the cap. Generally, program sponsors will reduce the number of allowances available over time, effectively lowering the cap and reducing emissions. In its most basic form, the cap and trade program offers the advantage of a known maximum quantity of emissions for a given pollutant.

After an initial distribution of allowances, companies are free to buy and sell them in accordance with their compliance needs or as an investment vehicle like any other commodity. This trading component allows those participants with the lowest cost of abatement to reduce emissions at a price below the prevailing trading price, and those with higher cost of abatement to purchase allowances at a price below their own costs of abatement.

While the trade component of cap and trade drives overall compliance costs down, the ultimate level of those costs is impossible to know and difficult to forecast. This is a major disadvantage of a cap and trade program, particularly as it relates to a carbon tax, where the cost per ton is generally known in advance. Some of the greatest opposition to cap and trade programs is driven by a fear of out of control allowance costs and their impact on energy prices and the economy in general. Policymakers have a number of tools to mitigate this risk when implementing cap and trade, but they each, in their own way diminish the advantage of certainty around total emission levels. Most programs have multi-year compliance periods and many programs allow banking of allowances for use in subsequent years within the compliance period. This allows companies to build up reserves of allowances when they perceive costs are low, or their need to use allowances for compliance is low. However, this may result in lower emissions than projected in initial years

and higher emissions in subsequent years. Similarly, some programs allow borrowing of allowances from future years, which will shift emissions forward and reduce the cap in later years. This is potentially more problematic as a tighter cap in the future years will likely raise allowance prices and increase political pressure to raise or loosen the cap.

Another common cost containment mechanism is offsets. Offsets are reductions that occur outside of the regulated sectors or the regulated boundary that may be purchased by companies that are subject to the cap. Because GHGs are typically well-mixed global constituents this appears logical, as the radiative impact of given amount of GHG is no higher or lower based on the location of its release. Although most cap and trade programs have limits on the use of offsets and rigorous protocols for their accounting, it remains difficult to ensure that offsets do not raise the overall level of global emissions. This can happen when reductions from offset projects are not additional to business as usual, “leak” to other sectors, or are not estimated properly. This can lead to offset projects that actually don’t provide any real reductions being used as compliance mechanism for cap and trade covered sectors to continuing emitting at high levels. Important issues related to offsets include additionality, project accounting boundaries, and leakage.

The most blunt cost containment mechanism is a price cap. A price ceiling may come in the form of a hard cap, which establishes a maximum price in the market. California’s cap and trade program has a soft cap, whereby additional allowances may be made available from future compliance years to mitigate price shocks in early years. Often, a price floor is also employed, partially as a mechanism for raising funds to be used by the program sponsor and also to ensure that regulated entities have an incentive to control emissions, even in oversupplied markets. In either case, either a price floor or a price ceiling distorts markets, and diminishes the information available to market participants on the scarcity or abundance of allowances.

When developing a cap and trade program, the regulating entity must determine the coverage of the program, including the pollutants capped, the geography of the coverage and the sectors covered. The method for the initial distribution of allowances must also be determined. Initially, allowances may be allocated freely or they may be auctioned. Ultimately, the distribution method will have little effect on the value of allowances, which is determined by their incremental scarcity relative to emission levels and the marginal cost of reducing emissions to eliminate that scarcity; however, the allocation of allowances confers valuable property rights with the potential for important distributional impacts. There are those who point out that forcing regulated entities to purchase allowances through auctions consumes valuable capital that could otherwise be spent on emission reductions. Further, these entities are likely to pass on a substantial portion of auction costs to consumers. Others suggest that rewarding the polluting community with this valuable property right is unjust. Some go on to argue that because these allowances have value, their “cost” is passed on to consumers anyway, even though the initial holders of allowances did not have to pay for them.

The following section, Section 4.2, discusses previous work analyzing the potential for a cap and trade program in Washington State, generally within the context of the Western Climate Initiative (WCI). Section 4.3 offers an analysis of the potential reductions that could be generated from a Washington cap and trade program, and estimates the value of the allowance commodity created under such a regime. Finally, Section 4.4 offers an overview of cap and trade programs implemented in California, the European Union, RGGI, and elsewhere. Further implementation history is available in Appendix A.

4.2 Literature Review of Washington Potential

In February 2007, the Governors of Arizona, California, New Mexico, Oregon, and Washington signed an agreement to develop a regional target for GHG emission reductions and develop a market-based program to achieve the target, establishing the WCI.¹³ The Governors of Montana and Utah and the Premiers of British Columbia, Manitoba, Ontario, and Quebec joined the WCI during 2007 and 2008. However, the shifting political landscape in the region, along with economic concerns from the financial crisis, led several states to pull out of the WCI. Arizona, Montana, New Mexico, Oregon, Utah and Washington formally withdrew from the WCI in 2011. California, British Columbia, Ontario, Quebec and Manitoba are continuing to work together through Western Climate Initiative, Inc. (WCI, Inc.) to develop a cap-and-trade program.¹⁴

Washington was an original partner in the WCI, which aimed to implement a cap-and-trade program for Western states and Canadian provinces. The program set a goal of reducing GHG emissions 15 percent below 2005 levels by 2020.¹⁵ The program was designed to cover emissions of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride. Industries that would be covered include electricity generation (including emissions from electricity generated outside the WCI jurisdictions), combustion at industrial and commercial facilities, industrial processes, residential, commercial and industrial fuel combustion facilities, and transportation fuel combustion. The WCI design also includes the implementation of complementary policies.¹⁶

California has moved forward with its own cap and trade program, with its first auction of allowances occurring in November 2012 and three additional auctions occurring subsequently.

¹³ Western Climate Initiative. Archived site. <http://www.westernclimateinitiative.org/index.php>

¹⁴ Western Climate Initiative, Inc. (WCI, Inc.) is a non-profit corporation formed to provide administrative and technical services to support the implementation of state and provincial greenhouse gas emissions trading programs. WCI Inc. <http://www.wci-inc.org/index.php>

¹⁵ The Western Climate Initiative. Archived site. <http://www.westernclimateinitiative.org/the-wci-cap-and-trade-program>

¹⁶ Design Recommendations for the WCI Regional Cap-and-Trade Program. March 2009. <http://www.westernclimateinitiative.org/the-wci-cap-and-trade-program/design-recommendations>

Quebec has also established a cap and trade program. These programs are poised to be linked beginning in 2014, and staff in California and Quebec are working to establish necessary policy frameworks.¹⁷ Should Washington pursue a cap and trade program, alignment and linkage with California and Quebec would create a larger and more economically efficient cap and trade program.

The following sections provide a review of three studies conducted between 2009 and 2010 that analyze the potential economic impacts to Washington and the region of the proposed cap-and-trade program designed as part of the Western Climate Initiative (WCI).¹⁸ The following three studies are reviewed:

- Updated Economic Analysis of the WCI Regional Cap-and-Trade Program. July 2010. (WCI Economic Modeling Team)¹⁹
- Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. (ECONorthwest)²⁰
- The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. (Beacon Hill Institute)²¹

The first two studies found that implementing cap and trade in the WCI jurisdictions including Washington would have a positive impact on economic factors including job creation and economic output. The third study by the Beacon Hill Institute contradicts these findings, showing job losses and decreases to investment, personal income, and disposable income. Each study and its findings are summarized below.

4.2.1 WCI Economic Modeling Team Analysis

In September 2008, the WCI Partner jurisdictions released their Design Recommendations for the WCI Regional Cap-and-Trade Program.²² An analysis of the economic impacts of the cap-

¹⁷ California Environmental Protection Agency, Air Resources Board. April 2013. Air Resources Board sets date for linking cap-and-trade program with Quebec. Accessed July 2013 at: <http://www.arb.ca.gov/newsrel/newsrelease.php?id=430>

¹⁸ Western Climate Initiative. March 2009. Design Recommendations for the WCI Regional Cap-and-Trade Program. Accessed August 2013 at: <http://www.westernclimateinitiative.org/document-archives/wci-design-recommendations>

¹⁹ Updated Economic Analysis of the WCI Regional Cap-and-Trade Program. July 2010. (WCI Economic Modeling Team). http://www.westernclimateinitiative.org/document-archives/function/download/265/chk,2eaf81e0b154d203d8f64fa595cbf76/no_html,1/

²⁰ Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. (ECONorthwest). http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf

²¹ The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. (Beacon Hill Institute) <http://www.washingtonpolicy.org/sites/default/files/WesternClimateInitiative.pdf>

and-trade program to the region was completed by the WCI Economic Modeling Team (EMT), along with support contractors, in September 2008 as part of the design process. The analysis was updated in 2010 to account for expansion of the WCI (to include Manitoba, Québec, and Ontario) and the economic downturn of 2008–2009. The updated analysis also includes various model improvements identified by the EMT and stakeholders. The analysis used ENERGY 2020, a well-established energy model, to simulate energy demand, energy supply, energy costs, and GHG emissions under user-defined scenarios across multiple regions and sectors.²³ The model was run under a main policy scenario along with several sensitivity scenarios. The main policy scenario modeled the cap-and-trade program as designed and included the impact of complementary policies and the use of offsets and banking of allowances.²⁴ The analysis assumed that all reductions came from sectors covered by the cap. Emissions from electricity imported into the WCI Partner Jurisdictions from outside jurisdictions are included in the analysis. The sensitivity scenarios modeled situations where the complementary policies achieve only half of their anticipated GHG reductions, there is a faster rate of economic growth and lower fuel prices, higher fuel and electricity generation costs, and alternative carbon prices. The complementary policies included energy efficiency targets and standards, emissions performance standards for electric power, renewable energy standards, renewable fuels standards, transportation planning, mass transit, government procurement policies, and direct government funding and investment in key technologies.

The analysis resulted in the following conclusions:

- The WCI emissions reduction goal for 2020 can be achieved with a net cost savings of approximately \$100 billion in the WCI region over the 2012 to 2020 period. The cost savings, although significant, are less than 0.2 percent of the total economic size of the 11 WCI Partner jurisdictions.
- The allowance price would be \$33 per metric ton carbon dioxide equivalent in 2020, which is comparable to the results of other independent studies.
- Complementary policies produce cost savings and have the potential to significantly reduce emissions. With complementary policies modeled at roughly half as effective as assumed in the main policy case, the allowance price would need to exceed \$50 per metric ton to achieve the regional reduction goal.

²² Design Recommendations for the WCI Regional Cap-and-Trade Program. March 2009.

http://www.westernclimateinitiative.org/document-archives/function-download/14/chk.4fd4d111cfca96e0dcb0223b1f210c0c/no_html.1/

²³ Additional information about the ENERGY 2020 model can be found at the following link:

<http://www.energy2020.com/ENERGY%202020%20Model%20Overview.htm>.

²⁴ The model enabled allowances to be banked when allowance prices are low and for banked allowances to be used when allowance prices are high.

Table 9 shows the cost savings and allowance prices expected under the main policy case and the sensitivity cases.

Table 9. Cost Savings and Allowance Prices from Economic Modeling Scenarios

Economic Modeling Scenarios	Cost Savings 2012–2020 (2007 US\$)	Emissions Allowance Price in 2020 (2007 US\$)
Main Policy Case	\$102 billion	\$33 per metric ton
Sensitivity Cases		
Complementary policies only half as effective as in main case	At least \$38 billion	At least \$50 per metric ton
Faster economic growth and lower primary energy prices	At least \$202 billion	At least \$50 per metric ton
Higher energy prices and power plant construction costs	\$106 billion	\$13 per metric ton

4.2.2 ECONorthwest Analysis

In 2010, the Washington State Department of Ecology contracted with economic consulting firm ECONorthwest to estimate the potential economic impacts to Washington if the cap-and-trade strategy proposed by the WCI was implemented.^{25,26} The analysis builds on previous WCI modeling conducted by the WCI Economic Modeling Team that used the ENERGY 2020 model.²⁷ The ENERGY 2020 model was used to forecast changes in energy prices and energy demand that would result from a cap-and-trade system as part of the process of developing WCI design recommendations.

The results of the ECONorthwest analysis indicate that that the WCI cap-and-trade strategy, if implemented as designed, would result in a net increase of 19,300 jobs and increased economic output of \$3.3 billion in Washington State by 2020. The ECONorthwest analysis assumed that member jurisdictions enacted four complementary policy measures in addition to the cap-and-

²⁵ Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf

²⁶ The study was funded through a grant from the Energy Foundation, <http://www.ef.org/>

²⁷ ENERGY 2020 is an integrated multi-sector energy model that estimates energy demand and supply. The model also simulates energy-related decisions and their impacts on GHG emissions. It is not a macroeconomic model such as REMI, which simulates the behavioral response of the aggregate economy in terms of changes in GDP, employment and other macroeconomic variables. Energy 2020 simulates detailed end uses for three residential categories, 40 NAICS commercial and industrial categories, and three transportation service categories. The stock and turnover of equipment and buildings is explicitly modeled as are investments in energy efficiencies and expenditures on energy consumption.

trade framework. These complementary measures were also modeled in the ENERGY 2020 analysis and include:

- **Energy Efficiency.** Energy efficiency for electricity and natural gas increases 0.5 percent per year starting in 2012. The previous ENERGY 2020 analysis captured the fuel savings, changes to annualized device and process investments, and changes in operations and maintenance (O&M). The modeling effort also included program administration cost, which was forecast to be \$0.6 billion by 2020.
- **Clean Car Standards.** By 2020, per-mile GHG emissions from vehicles decrease by 17 percent.²⁸ ENERGY 2020 captured the fuel savings, increase in device investment, and increase in O&M. This is equivalent to California's Pavley II (LEV-II) and the policy starts in 2017.
- **VMT Reduction.** Vehicle Miles Traveled (VMT) are lower by 2 percent from the reference case by 2020, beginning in 2008. ENERGY 2020 modeled the fuel savings and decrease in device investment and O&M due to less wear and tear on the vehicles. ENERGY 2020 did not capture the cost of bringing about the VMT reduction but the implementation costs were assumed to be small.
- **Ontario Coal Phase-out.** Ontario phases out all of its coal generation over the 2009 – 2015 time period.²⁹

The analysis modeled three policy scenarios. The primary scenario modeled the impact of the WCI cap-and-trade strategy as designed, called the WCI Policy scenario. This scenario used the following key assumptions:

- The complementary policies are included;
- Banking of allowances is allowed;
- Offsets are allowed for up to 49 percent of emissions reductions; and
- Allowance costs are capped at \$30.

Two additional scenarios were modeled to address a range of possible market conditions. The two additional scenarios included:

- **Less Effective Complementary Policies Scenario.** This scenario assumed that the complementary policies are only half as effective as in the WCI Policy scenario and that the allowance price is capped at \$50 instead of \$30.

²⁸ The reference runs, main policy case, and sensitivity cases in the previous WCI modeling all include Clean Car Standards through 2016. This includes Federal GHG emissions and CAFÉ standards which align with the GHG emission standards previously proposed by California. Efficiency improvements beyond 2016 (Pavley II) are included the complementary policies runs.

²⁹ The WCI was a regional program and included the Canadian provinces of Manitoba, Québec, and Ontario.

- **High Energy Cost Scenario.** This scenario assumes fuel prices and generation costs are higher than expected in the WCI Policy scenario. This scenario assumes that energy prices start at 2008 prices and increase in real terms by 50 percent by 2020. The high power generation cost case assumes that capital and O&M costs are 30 percent higher than in the WCI Policy case. Allowance prices capped at \$10 in this scenario.

All the scenarios showed increases in jobs and economic output. However, the “less effective complementary policies” scenario showed less job growth and economic output than the “WCI policy” scenario. The “high energy cost” scenario showed higher job growth and economic output. Table 10 shows the increase in jobs and economic output from each of the three scenarios modeled.³⁰

Table 10. Summary of Job and Economic Output from Modeled Scenarios in 2020

Scenario	Jobs	Economic Output (Million \$)
WCI Policy	19,300	\$3,309
Less Effective Complementary Policies	845	\$695
High Energy Cost	25,358	\$4,361

The analysis examined how potential economic benefits and costs would be distributed across Washington industries and found that the major sources of spending would occur in the following areas:³¹

- All commercial and industrial customers will have an increase in economic output over time if they have made investments in energy efficient equipment. Similarly, households that have purchased energy efficient equipment will have lower energy bills and consequently more money to spend on other goods and services.
- Suppliers of energy efficient equipment (contractors, construction, retail trade sectors) will benefit from increased spending on energy efficient equipment.
- Residential and commercial sector customers will have an increase in costs due to greater investments in energy efficiency equipment relative to the Reference Scenario. These higher costs are mitigated by energy cost savings for these same customers in future years after the initial investment is made.

³⁰ The analysis did not provide details on the specific mechanisms for job growth for each scenario.

³¹ Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf

The analysis finds that, given the nature of the spending that is likely to occur due to the WCI Policy, most of the job increases will occur in established industries. Much of the expected job growth would come from contractors supplying and installing energy efficient equipment such as windows, insulation, commercial lighting, air conditioners, and heat pumps. These types of contractors, although not traditionally considered green jobs, will likely see economic benefits as spending on these types of measures increases in response to the WCI Policy.³²

4.2.3 Beacon Hill Institute Analysis

The Beacon Hill Institute at Suffolk University (BHI) analyzed projections of cost savings conducted by the WCI during the design of the cap-and-trade system and conducted an independent economic impact estimate based on the policy scenarios in the WCI analysis.³³ The WCI analysis included three cap-and-trade policy scenarios that represent broad and narrow scopes for the program. The narrow scope scenario covers stationary sources (both combustion and process) and the electric sector. The broad scope adds transportation fuels and residential and commercial fuels. The WCI analyzed the following three cases:

- Broad Scope, with complementary policies and without offsets
- Broad Scope, with complementary policies and with offsets
- Narrow Scope, with complementary policies and with offsets

BHI modeled the impact on the economies of the then seven U.S. member states under the three policy scenarios. The WCI design recommends that member states auction at least 25% of the GHG permits by 2020, with a goal of auctioning 100% of permits. BHI modeled the three scenarios under both a 25 percent and 100 percent auction. The analysis used the STAMP® (State Tax Analysis Modeling Program) to model the impact on employment, wages and income on the member state economies. STAMP is a five-year dynamic computable general equilibrium (CGE) model that simulates changes in taxes, costs (general and sector specific) and other economic inputs.³⁴ The analysis assumed that the auctioning of permits would create revenue for the states and modeled revenue from the auctions as a change in state tax policy. The percentage of permits not auctioned was treated as a price increase. The analysis utilized the weighted change of fuel costs (increases) for energy and transportation fuels as estimated in the three cap-and-trade cases from the WCI report and modeled these changes in STAMP as a state tax or price increase on fuel to measure the dynamic effects on the state economies.

³² Ibid.

³³ The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. <http://www.washingtonpolicy.org/sites/default/files/WesternClimateInitiative.pdf>

³⁴ For more information about the STAMP modeling program see the Beacon Hill website: http://www.beaconhill.org/STAMP_Web_Brochure/STAMP_EconofSTAMP.html

The BHI analysis found that a cap-and-trade policy, as recommended by the WCI, would have substantial negative effects on member states by 2020. The analysis showed a decrease in employment, investment, personal income, and disposable income in every member state. The results of the analysis contrast with the positive results of the original WCI assessment, which showed total cost savings for the region.³⁵ The “narrow with offsets” scenario with a 100 percent permit auction resulted in the least amount of job losses and personal income reductions. BHI found that under this scenario Washington could lose 2,800 jobs and see personal income reduced by over \$760 million. The “broad with no offsets” scenario with a 25 percent auction showed the highest job losses and income reductions. BHI found that under this scenario Washington could lose over 18,000 jobs and see personal income decrease by over \$5 billion.³⁶

Table 11 shows a summary of the total impact on employment, private investment, personal income, and disposable income for all member states for each of the scenarios modeled. Table 12 shows the range of potential impacts on employment and personal income for each of the member states individually.

Table 11. Summary of BHI Estimates in 2020

Policy Scenario	Employment		Gross Private Investment (\$ million)	Personal Income (\$ million)	Disposable Income (\$ million)	Disposable Income (\$ per Capita)
	Private	Public				
Auction 100% of Allowances						
Broad, No Offsets	-251,674	142,241	-1,448.41	-18,308.56	-17,420.86	-172.6
Broad, Offsets	-113,558	57,269	-712.57	-10,451.68	-7,838.56	-78.35
Narrow, Offsets	-103,931	83,519	-547.75	-6,344.97	-5,138.98	-59.23
Auction 25% of Allowances						
Broad, No Offsets	-165,397	19,710	-4,539.55	-47,706.88	-30,316.49	-272.34
Broad, Offsets	-59,240	6,920	-989.22	-13,094.59	-6,302.83	-62.65
Narrow, Offsets	-35,177	-354	-1,620.21	-10,195.15	-6,341.78	-63.47

Table 12. Range of Impact on Jobs and Personal Income by State in 2020

State	Net Employment jobs	Personal Income (\$ million)	Per Capita Disposable Income (\$)
Arizona	-4,801 to -20,496	-722.27 to -5,397.10	-47.60 to -224.98
California	-7,886 to -78,694	-4,038.18 to -30,398.72	-62.72 to -287.63

³⁵ The WCI analysis did not model impact on employment.

³⁶ It is unclear whether the analysis specifically modeled the impacts of increased investment in energy efficiency which has been shown in other analyses to potentially lead to job growth.

Montana	-548 to -2,869	-91.77 to -689.21	-54.77 to -250.79
New Mexico	-8 to -4,689	-165.16 to -1,242.23	-47.84 to -219.41
Oregon	-1,823 to -10,748	-320.60 to -2,419.17	-46.42 to -213.65
Utah	-2,546 to -9,899	-246.34 to -1,846.52	-40.38 to -185.83
Washington	-2,800 to -18,292	-760.64 to -5,713.92	-66.02 to -302.54

4.3 Quantification

This section builds on previous analysis of the potential GHG emission reductions that could be generated from implementation of a cap and trade program in Washington. This analysis is much more limited in scope than the work previously conducted and is intended to provide an analysis consistent with the others produced that can be used for high-level policy evaluation, and which attempts to separate the contribution of the cap and trade policy as distinct from other complementary policies. While emission reductions in the capped sectors may be significant, many of these reductions are actually attributable to other policy mechanisms. This analysis considers the effect of the cap and trade policy as only the emission reductions required in excess of complementary policies.

Importantly, this analysis projects beyond the initial reduction assessments for 2020, out to 2035 and 2050 to provide a picture of the long-term outcomes that could be expected from the cap and trade policy. This is important as many of the complementary policies currently in effect diminish the impact of cap and trade in the near term.

The cap and trade policy examined in this section assumes the emission cap in the years 2020, 2035 and 2050 match the Washington State GHG reduction goals which were based on the initial WCI target of 1990 levels by 2020, 25% below 1990 levels by 2035 and 50% below 1990 levels by 2050. Annual reductions were estimated for each of these years, assuming that the caps were met.

Reductions from existing complementary policies were incorporated into the analysis. It was assumed that the cap and trade policy would work as a safety net to ensure reduction goal achievement, by reducing emissions beyond what the complimentary policies were able to achieve. The cap and trade policy was not given credit for reductions estimated for each of the existing complementary policies, which include:

- Energy Independence Act (I-937)
- Purchase of Clean Cars
- Washington's Renewable Fuel Standard (RFS)
- Public Fleet Conversion to Clean Fuels
- Appliance Standards
- Energy Code Policies

- Energy Efficiency and Energy Consumption Programs for Public Buildings

4.3.1 Methodology

The sectors included in the analysis and assumed to be covered by a cap and trade policy are Electric Power Generation, Transportation Fuels (on road gasoline and diesel, aviation fuels, rail, and marine vessels), and RCI natural gas and fuel oil only, as electric power generation is already covered on the generation side and emissions from direct coal combustion in these sectors are very small and have already been reduced to 50% below 1990 levels. These sectors represent about 85% of total emissions in Washington State. The sectors were chosen based on WCI and California policy designs, as well as Washington's specific emissions inventory profile. Industrial process emissions were not included for several reasons, even though certain industrial sectors are included by California and WCI. First the overall contribution of industrial process emissions to Washington's total emissions is just 4 percent. Each individual industrial sector is showing reductions or no growth in GHG emissions except Ozone Depleting Substance (ODS) Substitutes which did not exist in 1990. The ODS Substitute sector is expected to be addressed by federal policy. Finally overall industrial sector process emissions have almost reached the 2050 target, currently 47 percent below 1990 levels, even with the addition of ODSs.

Emissions from the covered sectors were equal to 70.6 MMTCO₂e in 1990. A compliance pathway was constructed using the targets of 1990 emission levels by 2020, 25 percent below 1990 levels by 2035, and 50 percent below 1990 levels by 2050. These were the targets outlined by WCI and used in previous analyses of cap and trade impacts on emissions in Washington. The emission cap levels for each sector were based on the 1990 emissions estimate from the Washington State Greenhouse Gas Emissions Inventory 1990-2010 report and are provided in Table 13.

Table 13: Emission Caps (Million Metric Tons)

Cap and Trade Covered Sector	1990 level	Emissions Cap		
		2020	2035	2050
Electricity Generation	16.9	70.6	53.0	35.3
Transportation Fuels	37.0			
RCI (Natural Gas and Fuel Oil)	16.7			
Total Emission Cap (All Covered Sectors)	70.60			

There are no caps set for individual sectors in 2020, 2035, and 2050, but only total emissions across all sectors. It is not expected that each sector will meet the cap independently or proportionately but that all the sectors as a whole will meet the cap, depending on where emissions can be reduced the most cost effectively. Sectors with higher cost to reduce emissions will likely continue to emit at higher rates and purchase allowances from sectors that can most cost effectively reduce, even far below their 1990 levels.

To quantify the emission reductions from the cap and trade policy, baseline emissions forecasts were created for each of the covered sectors independently. All baseline emission forecast estimates used the updated Washington State Dept. of Ecology 2013 emission projections as a starting point, except for the electric generation forecast which was based of the I-937 projection of emissions done as part of task 1.

Table 14: Baseline Emission Forecasts by Sector

Cap and Trade Covered Sector	2020	2035	2050
Electricity Generation	28.5	38.8	42.7
Transportation Fuels	42.7	40.3	39.4
RCI (Natural Gas and Fuel Oil)	21.1	20.2	19.5
Total Emissions (All Covered Sectors)	92.3	99.4	101.7

These baseline emission forecasts were then adjusted based on the emission reductions expected from the applicable existing complementary policies to develop a business as usual (BAU) forecast. Table 12 below provides the expected annual reductions from the existing complementary policies, including interactions, in the target years.

Table 15: Complimentary Policy Reductions (MMTCO₂e)

	2020	2035	2050
Reductions from existing complementary policies not included in baseline projection	9.6	24.4	30.5

*Details on reduction estimate methodologies for all complimentary policies can be found in Final Task 4 Report.

The adjusted BAU forecast for all sectors was compared to the compliance pathway based on the target year emission caps. The difference between these two estimates across all sectors was assumed to be the emission reductions that the cap and trade policy was responsible for.

4.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions about the structure of the Cap and Trade policy, the path towards attainment, associated data parameters, and exclusions are included in this analysis.

- The emissions cap matches the initial Washington State reduction goals and the WCI targets of 1990 emission levels by 2020, 25% below 1990 levels by 2035, and 50% below 1990 levels by 2050.
- The total emission cap will be met in each target year.
- The cap and trade policy was not given credit for reductions estimated from the existing complementary policies.

- The sectors included in the analysis and assumed to be covered by a cap and trade policy are Electric Power Generation, Transportation Fuels (on road gasoline and diesel, Aviation fuels, Rail, and Marine Vessels), and RCI Stationary Combustion (natural gas and fuel oil).
- Electricity generation sector emission forecasts were based on the I-937 emission projection completed previously.
- Transportation fuel sector emission forecasts were based on the emission projections and growth rates as provided by Washington State's Dept. of Ecology's 2013 emission projection update.
- RCI sector emission forecasts were based on emission projections and growth rates as provided by Washington State's Dept. of Ecology's 2013 emission projection update.
- Emission and consumption growth rates were assumed to remain constant from 2035 to 2050 in each sector.
- Emission reductions from complimentary policies impacting the electricity sector accounted for the overlap and interactions between I-937, EPS, Energy Codes, appliance standards and programs for public buildings.
- Emission reductions from complimentary policies impacting the transportation sector accounted for LEV III reductions only, all other policies were already accounted for in the Dept. of Ecology 2013 emission projection.
- Emission reductions from complimentary policies impacting the RCI sector accounted for the non-electricity reductions from Energy Codes.

The primary data sources used in this analysis include:

Data		Source
GHG Forecasts		Washington State GHG Inventory, Appendix 3: Washington GHG Emissions Projection 2009-2035. http://www.ecy.wa.gov/climatechange/docs/ccp_appendix3.pdf
1990-2010 Washington State GHG Emission Estimates		Washington State Greenhouse Gas Emissions Inventory 1990-2010. https://fortress.wa.gov/ecy/publications/publications/1202034.pdf
Allowance Options	Price	<ul style="list-style-type: none"> • Updated Economic Analysis of the WCI Regional Cap-and-Trade Program. July 2010. (WCI Economic Modeling Team). http://www.westernclimateinitiative.org/document-archives/function/download/265/chk,2eaaf81e0b154d203d8f64fa595cbf76/no_html,1/ • Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. (ECONorthwest). http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf • The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. (Beacon Hill Institute) http://www.washingtonpolicy.org/sites/default/files/WesternClimateInitiative.pdf

Complementary Policy Reduction Estimates	<ul style="list-style-type: none"> • DRAFT Task 1B - Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State • Task 4 Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State –Final Report.
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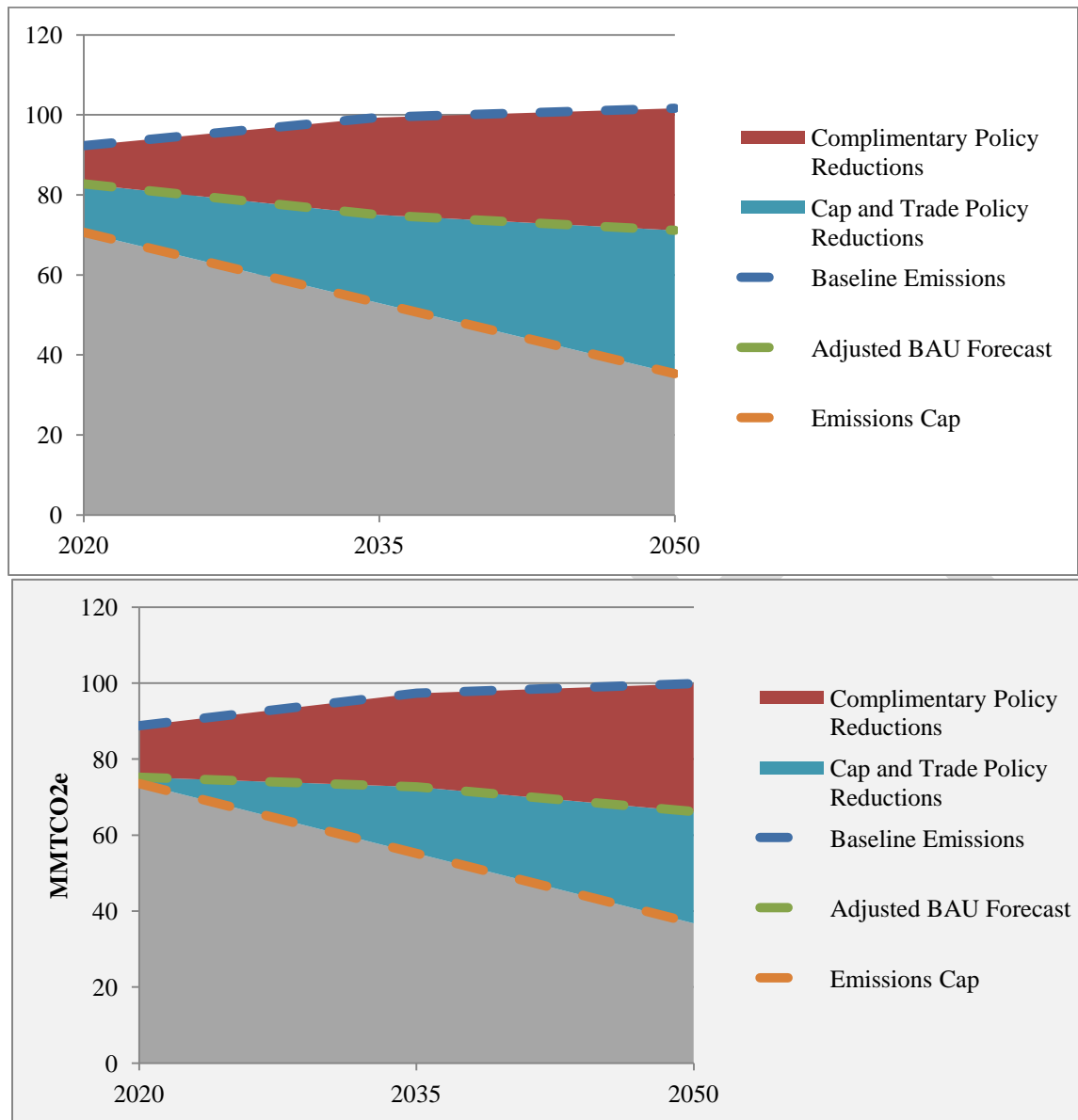
4.3.3 Results

Results for the emission reduction estimates calculated based on the methodology described above are provided in Table 16.

Table 16: Washington State Cap and Trade Program Results

Results	2020 (MMTCO ₂ e)	2035 (MMTCO ₂ e)	2050 (MMTCO ₂ e)
Covered Sector Baseline Emissions	92.3	99.4	101.7
Complimentary Policy Reductions in Covered Sectors	9.6	24.4	30.5
BAU Forecast (Adjusted Baseline)	82.7	75.0	71.2
Emissions Cap	70.6	53.0	35.3
Cap and Trade Policy Reductions	12.1	22.1	35.9

The results indicate that the sectors in Washington State assumed to be covered by a cap and trade program in this analysis are on track to miss the emission reduction goal of 1990 levels by 2020 by 12.1 MMTCO₂e, without a cap and trade program. However, over time the difference between the emissions cap and Washington's projected BAU emissions widens significantly, by 2035 over 22.1 MMTCO₂e separate the target of 25% below 1990 levels and the projected emissions of the covered sectors, and that figure grows to 35.9 MMTCO₂e by 2050. Assuming that all sectors comply with the policy, cap and trade in conjunction with other policies targeting the capped sectors would be responsible for closing the gap between the BAU forecasted emissions and the emissions cap.

Figure 2: GHG Emissions Impact of Cap and Trade Policies

The broader economic impacts that would result from a Washington State cap and trade program are most appropriately modeled using techniques similar to those described in section 4.2. These analyses give State level impacts on jobs, cost savings, economic output, personal income, and disposable income. This requires modeling the complex relationships between the program, energy prices, commercial and industrial energy use, investment, and many other variables. A simplified look at cap and trade costs can be estimated by looking at a range of allowance prices in any given year and the number of allowances allocated to each sector. Depending on the method of distribution of these allowances, either through free allocation or auction, the total value of the allowance is either borne as a cost to the covered sectors (and revenue for the state that can be reinvested) or provided as a valued commodity that can generate revenue for the

covered sectors. In either case the basic costs of the cap and trade are more accurately viewed as a transfer, either from covered sectors to each other, from the covered sectors to the state, or from consumers to the state or covered sectors. The allowance prices used in the studies reviewed in section 4.2 ranged from \$10 to \$30 to \$50 per metric ton CO₂e. These three prices will be used to provide a range of potential value/costs. However, it is important to note that these prices are not a forecasted expectation of price, but simply a range of possible scenarios. As discussed in Section 4.3, allowance prices in both the RGGI and the EU ETS are currently below \$5 per metric ton, while prices in the CA ETS are between \$10-\$15 per metric ton.

Using the same assumptions as described in the methodology above and these three allowance price options, it is possible to estimate the total value of the allowance commodity created by the cap and trade program. Total emission allowance value was determined individually for sectors based purely on their emission contribution to the overall cap, however depending on a number of variables, including competitive risks and leakage potential, these allowances and values may be distributed differently.

Table 17: Emission Allowance Commodity Value (potential cost to covered sectors/consumers and potential revenue to the State if 100% allocated through auctions)

Allowance Price/Sector	(Million \$USD)		
	2020	2035	2050
\$10/MTCO₂e			
Electricity Generation	\$169	\$127	\$85
Transportation Fuels	\$422	\$278	\$185
RCI (Natural Gas and Fuel Oil)	\$167	\$125	\$84
Total	\$758	\$530	\$353
\$30/MTCO₂e			
Electricity Generation	\$507	\$380	\$254
Transportation Fuels	\$1,266	\$833	\$555
RCI (Natural Gas and Fuel Oil)	\$501	\$376	\$251
Total	\$2,274	\$1,589	\$1,059
\$50/MTCO₂e			
Electricity Generation	\$845	\$634	\$423
Transportation Fuels	\$2,110	\$1,388	\$925
RCI (Natural Gas and Fuel Oil)	\$835	\$1,879	\$418
Total	\$3,790	\$3,900	\$1,765

The estimated costs to covered sectors and or their consumers and the state revenues of cap and trade program with 100% allocation through auction, based on the assumptions outlined above, range from \$732M if allowances are set at \$10/ton, to \$3.6B if allowances are set at \$50 a ton in

2020. It is also important to note that as the cap is reduced overtime so is the total value of allowance commodity.

4.4 Implementation History

The notion of market-based mechanisms for addressing environmental pollution was first explored by the British economist, Arthur Pigou, in the early 20th century. Pigou observed that the social costs of some industrial activities were not captured in the price of the products being exchanged.³⁷ In order to internalize these externalities (unacknowledged costs), Pigou suggested that taxes or fees equal to the social costs be imposed on the goods.³⁸ In 1960 Ronald Coase argued that by making property rights explicit and transferable, the market could play an important role in valuing these rights and ensuring that they gravitated to their highest value use. In 1968, John Dales applied these theories to water pollution control using tradable permits or allowances.³⁹ In the late 1980's, the administration of President George H.W. Bush proposed the most ambitious emission trading program in history, the Acid Rain Allowance Trading Program to cut emissions of sulfur dioxide. The Program became part of the Clean Air Act Amendments of 1990, and by most accounts is perceived as wildly successful. Between 1990 and 2010, U.S. sulfur dioxide emissions declined from 15.9 million tons annually to 5.1 million tons. Annual net benefits are estimated at between \$59 billion and \$116 billion,⁴⁰ compared with annual costs between \$0.5 and \$2.0 billion.⁴¹ Costs of compliance are estimated to be anywhere from 15 to 90 percent below a more traditional command and control approach.⁴²

As concerns grew about the impact of greenhouse gases on the global ecosystem, policymakers pursued multilateral agreements to slow or reverse the growth of greenhouse gas emissions, and they sought regulatory approaches that minimize economic costs. In 2005, looking at the successful U.S. experience with the Acid Rain Allowance Program, the European Union launched its Emissions Trading Scheme (ETS) to reduce greenhouse gas emissions. Several cap and trade programs have been subsequently launched in New Zealand, the Northeast of the

³⁷Richard Coniff, *The Political History of Cap and Trade*, Smithsonian Magazine, August 2009, <http://www.smithsonianmag.com/science-nature/Presence-of-Mind-Blue-Sky-Thinking.html>

³⁸ Please see accompanying discussion of carbon taxes.

³⁹ Tom Tietenberg, *The Evolution of Emissions Trading*, Colby College, http://www.aeaweb.org/annual_mtg_papers/2008/2008_90.pdf

⁴⁰ Most of the benefits are associated with improved human health rather than ecological health as originally anticipated.

⁴¹R. Schmalensee and R. Stavins, *The SO₂ Allowance Trading System: The Ironic History of a Grand Policy Experiment*, Resources for the Future Discussion Paper, August 2012. <http://www.rff.org/RFF/Documents/RFF-DP-12-44.pdf>

⁴² Though a substantial portion of these savings (perhaps on the order of one-third) can be attributed to the deregulation of the railroad industry that permitted low-sulfur western coal to be brought to utilities in the East and Midwest.

United States, and in California. Each of these programs differs in some respects but they all provide valuable lessons learned when contemplating a program for Washington.

California Cap and Trade Program. As a potential linking partner and the regional pioneer in this space, the California Cap and Trade Program provides particularly relevant lessons for Washington. The California Global Warming Solutions Act of 2006 (AB 32) set targets for GHG reductions in California relative to an anticipated business as usual trajectory. By 2020, the bill calls for California emissions to return to the 1990 level of 427 million metric tons of carbon dioxide equivalent (MMTCO₂e), a reduction of approximately 77 MMTCO₂e. To reach this goal, the AB 32 Climate Change Scoping Plan Document established a suite of policy mechanisms with a cap-and trade program as the centerpiece.⁴³

The California Cap and Trade Program will regulate approximately 35 percent of California's GHG emissions in the first compliance period (2013-2014) by covering the electricity sector and certain industrial sectors. The program will expand to cover 85 percent of California emissions in the second and third compliance periods (2015-2017 and 2018-2020) when transportation fuels and natural gas suppliers are included. In addition to emissions from in-state sources, electricity imported to California is also subject to a compliance obligation corresponding to its emissions. This compliance obligation is the responsibility of the electricity importer, and not the out-of-state entity generating the power.⁴⁴

Allowances are distributed through a variety of mechanisms including free allocation to industry, free allocation to electricity distributors (for the benefit of ratepayers), and auctions. The percent of freely allocated allowances will decline over time. For vintage 2013, over 90 percent of allowances were freely allocated. Auctions are held on a quarterly basis and include both current vintage allowances and an advance auction of future vintage allowances. The auction mechanism utilizes a settlement price corresponding to the minimum price – working downwards from the highest bid – at which all available allowances are sold. There is also a price floor below which allowances will not be sold. The price floor was \$10.00 in 2012, increasing five percent plus inflation each year thereafter. There have been three auctions conducted to date, with prices for current vintages ranging from \$10.09 to \$14.00 per mtCO₂e.⁴⁵ The California program allows the use of GHG offsets to meet up to 8 percent of each regulated entity's compliance obligation.

⁴³ California Air Resources Board. December 2008. Climate Change Scoping Plan: a framework for change. Accessed August 2013 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

⁴⁴ California Environmental Protection Agency, Air Resources Board. April 2013. Article 5: California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms. Accessed July 2013 at: http://www.arb.ca.gov/cc/capandtrade/ct_rf_april2013.pdf

⁴⁵ California Air Resources Board. July 2013. Auction Information. Accessed August 2013 at: <http://www.arb.ca.gov/cc/capandtrade/auction/auction.htm>

As the California Cap and Trade Program is in its first year of its first compliance period, it is too early to assess programmatic success or costs. The California Air Resources Board (ARB) has attempted to make forecasts of key performance metrics:

- Market forces associated with cap and trade are expected to generate the additional 34.4 MMTCO₂e reductions necessary to meet the 2020 cap, and to facilitate the complementary measures.⁴⁶
- ARB modeling predicts a decrease in fuel use of 2 to 4 percent in 2020 relative to a business-as-usual projection.⁴⁷
- ARB estimates minimal, if any, impact on household income (0 to 0.1 percent decrease).
- A modest decrease in labor demand (0.3 to 0.6 percent) is expected given forecast allowance prices.
- Overall, ARB modeling indicates that the Cap and Trade program will reduce total economic output by a 0.1 percent annually.

California Cap and Trade auctions are already generating significant revenues, with the late 2012 auction and the 2013 auctions expected to generate on the order of \$500 million. The California Department of Finance (Finance) and ARB drafted, through a public consultation process, a three-year investment plan to identify “investments to help achieve greenhouse gas reduction goals and yield valuable co-benefits.”⁴⁸ The intent was that the plan would be submitted to the California Legislature, which would in turn appropriate cap and trade revenue to State agencies for implementation of programs to further the objectives of AB 32. The California Legislature passed a \$96.3 billion budget for the fiscal year 2013-2014 on Friday June 13, 2013. Although the Investment Plan recommended allocating cap and trade revenue to a variety of pre-existing programs that could begin to use the funds immediately, the approved FY 2013-2014 budget instead borrowed the expected \$500 million in auction proceeds to meet other budgetary needs. Governor Brown has stated that he borrowed the \$500 million to provide more time to set up programs that will use the funding effectively. No timetable for repayment has yet been issued.⁴⁹

European Union Emissions Trading Scheme. The EUETS was not only the first cap and trade program to address greenhouse gases but it might also be the most complex and ambitious. The EU ETS operates in all 28 EU countries as well as Iceland, Liechtenstein and Norway, covering

⁴⁶ California Air Resources Board. December 2008. Climate Change Scoping Plan: a framework for change. Accessed August 2013 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

⁴⁷ California Air Resources Board. October 2010. Staff Report: Initial Statement of Reasons. Accessed August 2013 at: <http://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm>

⁴⁸ California Department of Finance. May 2013. Cap and Trade Auction Proceeds Investment Plan: Fiscal Years 2013-14 through 2015-16, page 1. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/final_investment_plan.pdf

⁴⁹ Mulkern, Anne C. *Gov. Brown proposes to borrow \$500M from cap-and-trade revenue*. ClimateWire. May 15, 2013

sectors that are responsible for approximately 45 percent of total GHG emissions in those countries. The first phase was set up to be experimental to help develop the market and lasted from 2005 through 2007. The second phase went from 2008 through 2012. The third phase of the EU ETS runs from 2013-2020, and aims to lower emissions from covered sectors by 21 percent from 2005 levels by 2020.⁵⁰ The third phase includes some significant program changes. The scope of the EU ETS will be expanded to include additional sectors and gases, and an overall EU cap will be used instead of individual member state set caps.⁵¹ The default allocation method in the third phase will be auctions, though there will continue to be free allocation to manufacturing⁵² and industries identified as at risk of leakage.⁵³ The EU ETS market has historically utilized the Clean Development Mechanism (CDM) and Joint Implementation (JI) elements of the Kyoto Protocol to generate and obtain international offsets from developing and developed nations respectively. In addition, the EU is pursuing sector-based offset crediting through a new market mechanism.⁵⁴ Finally, the EU ETS is pursuing linkage with the Australian cap and trade system, beginning in 2015.⁵⁵

Given its relatively long history, the EU ETS is the most studied GHG cap and trade system and has faced significant challenges and criticisms over time. Some important lessons learned include:

- Over-allocation of allowances has posed challenges in assessing the program's long-term economic impacts. Key questions still remain as a result, (i) how tight a cap should be set in going forward to deliver a price point on emission allowances that will provide the desired level of emission abatement, and (ii) what consequences does this cap have for economic growth and competitiveness?⁵⁶ In its haste to establish a program, the EU ETS set caps based on inaccurate forecasts of future emissions. Accurate current and historical emissions data are essential to setting the right emissions cap.

⁵⁰ European Commission. July 2013. The EU Emissions Trading System (EU ETS). Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/index_en.htm

⁵¹ http://www.edf.org/sites/default/files/EU_ETTS_Lessons_Learned_Report_EDF.pdf

⁵² European Commission. January 2013. Free allocation based on benchmarks. Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/cap/allocation/index_en.htm

⁵³ European Commission. January 2013. Carbon leakage. Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/cap/leakage/index_en.htm

⁵⁴ European Commission. January 2013. International carbon market. Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/linking/index_en.htm

⁵⁵ European Commission. August 2012. Australia and European Commission agree on pathway towards fully linking emissions trading systems. Accessed July 2013 at: http://ec.europa.eu/clima/news/articles/news_2012082801_en.htm

⁵⁶ UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf

- The over-allocation of the market, meaning that the allowances available in the market exceed emissions, has led to very low prices over time. Allowances on the EU market have traded at a high of €32 in 2006 and at prices near zero when the price crashed during in 2007, but rebounded to trade back over €30 in 2008.⁵⁷ Currently prices are trading slightly above €4.
- There has been a lack of innovation as a result of the EU ETS, likely attributable to an insufficient price signal from allowance prices. A higher carbon price is likely required for inducing innovation.⁵⁸
- The EU ETS program has undergone significant revisions over time. A trading program should provide enough certainty and should cover a long enough time period to influence technology investment decisions.⁵⁹
- If allowance banking from year-to-year is allowed to help firms minimize cost and increase flexibility over time, the program must provide a predictable long-term policy environment that allows for this to occur and be incorporated into planning.¹²
- The EU ETS has been criticized for the windfall profits of companies who passed on the price of carbon to customers even though their allowances were obtained for free.⁶⁰ Several studies summarized by the U.K. Department of Energy and Climate Change concluded that free allocation may have a negative effect on both the environmental and cost effectiveness of the EU ETS. If using free allocations, there should be appropriate regulatory oversight of public utilities, and auction of most or all allowances.¹²

Despite these substantial challenges associated with the EU ETS, the results have been generally encouraging:

- Even with much higher carbon price expectations than the market delivered, only a small fraction of businesses expected downsizing or relocation due to these climate based policies, showing that negative impacts to employment and competition might not be significant, even with prices up to €40.⁸
- A recent report by the European Commission estimated that the EU would save an average of US\$26 billion (€20 billion) in fuel costs each year from 2016 to 2020.⁶¹

⁵⁷ <http://www.theguardian.com/environment/2013/jan/24/eu-carbon-price-crash-record-low>

⁵⁸ Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

⁵⁹ U.S. Government Accountability Office (GAO), 2008 report - Lessons Learned from the European Union's Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism; <http://www.gao.gov/new.items/d09151.pdf>

⁶⁰ Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

⁶¹ Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

- Most estimates place the total cost at less than 1 percent of the European Union's GDP and potentially as low as 0.01 percent of the EU's GDP⁶². Several studies claim that if all allowances were auctioned, rather than freely allocated, there would be no economic cost and could potentially see significant economic gains.⁶²
- A recent report by the European Commission estimated that the health benefits of improved air quality if the EU ETS tightened its 2020 cap would be in the range of \$4.3 billion to \$10.4 billion.

Regional Greenhouse Gas Initiative. The Regional Greenhouse Gas Initiative (RGGI) is a highly focused, cooperative effort among nine northeast states in the U.S. to regulate and reduce GHG emissions from the power sector only. RGGI is composed of individually-operating emission trading programs within each state that together have created a regional market for emission allowances. Development of RGGI began in 2003, with the first memorandum of understanding (MOU) being released in 2005. The first auction of emission allowances occurred in 2008, with the first three-year compliance period starting in January 2009. RGGI currently operates in Connecticut, Delaware, Maine, Massachusetts, Maryland, New Hampshire, New York, Rhode Island, and Vermont (New Jersey participated through 2011). Each State program was developed based on the agreed upon RGGI Model Rule, which includes capping emissions from the electric power plants and requiring that a certain percentage of emission allowances are provided through participation in regional auctions rather than free allocation. Currently, around 90 percent of all allowances are provided through auction, with the remaining sold directly to qualified sectors.⁶³ RGGI allows for the use of offsets from certain project types to substitute for emission allowances, up to 3.3 percent of a utility's reported emissions, encouraging investment in particular project types identified as high priority by the states. Although more narrowly focused than the EU ETS, the experience of RGGI has had some important similarities:

- There was a significant excess supply of allowances relative to actual emission levels in the region. Emissions have never approached the cap, peaking at 135 million tons in 2010 and dropping to 118 million tons in 2011. In 2012, with NJ dropping from the program, RGGI-covered emission levels hit a low of about 92 million⁶⁴.
- A New York State Energy Research and Development Authority analysis concluded that *"...three categories of factors are the primary drivers of the decreased CO₂... : 1) lower*

⁶² UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf

⁶³ Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading"; http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf

⁶⁴ RGGI CO₂ Allowance Tracking System; <https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=home.home&clearfuseattribs=true>

electricity load (due to weather; energy efficiency programs and customer-sited generation; and the economy); 2) fuel-switching from petroleum and coal to natural gas (due to relatively low natural gas prices); and 3) changes in available capacity mix (due to increased nuclear capacity availability and uprates; reduced available coal capacity; increased wind capacity; and increased use of hydro capacity)”.⁶⁵ RGGI is credited with helping reduce electric load and increasing renewable capacity through its funding of renewable energy and energy efficiency programs.

- As a result of the oversupply of allowances, auction prices have remained very low. From September 2008 to June 2013, auction clearing prices have ranged from a low of \$1.86 to a high of \$3.51, with an average of \$2.35/mtCO₂e and cumulative proceeds totaling \$1.35 billion.⁶⁶
- Even at the very low levels of auction prices the program has raised significant revenues, totaling \$825.5 million over the initial 3-year compliance period.⁶⁷
- Of the revenues raised, 66 percent have been reinvested in energy efficiency, 5 percent in renewable energy and 4.5 percent in administrative costs.
- In response to the very low auction prices, the 2014 regional cap has been reduced from 165 million (already adjusted down from 188 million due to NJ’s dropping out) to 91 million tons – roughly equivalent to 2012 emissions levels and a reduction of 45 percent of the previous cap. The cap will decline 2.5 percent each year from 2015 to 2020.
- Given the tighter cap, there are concerns that current cost control mechanisms will be insufficient. Thus, the participating states will establish a cost containment reserve (CCR), which is a reserved quantity of allowances, in addition to the cap, that would only be available if defined allowance price triggers were exceeded (\$4 in 2014, \$6 in 2015, \$8 in 2016, and \$10 in 2017, rising by 2.5 percent, to account for inflation, each year thereafter).
- Households in the RGGI region recognized a nearly \$1.1 billion net gain due to improvements in energy efficiency resulting from RGGI revenues.⁶⁸

New Zealand Emissions Trading Scheme. Like RGGI, the New Zealand Emissions Trading Scheme (NZ ETS) was launched in 2008, covering only a single sector (Forestry). It was designed to cover more sectors progressively over time, with the aim of including all sectors by 2015. The liquid fossil fuels, stationary energy, and industrial processes sectors joined in July 2010 and the waste and synthetic GHG sectors joined in January 2013. The agriculture sector

⁶⁵ Environmental Defense Fund – “RGGI: The World’s Carbon Markets: A Case Study Guide to Emissions Trading”;

http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf

⁶⁶ http://www.rggi.org/market/co2_auctions/results

⁶⁷ Note: The author of this study, SAIC was a member of the team conducting allowance auctions on behalf of RGGI Inc.

⁶⁸ Analysis Group’s November 2011 Report;

http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf

was originally scheduled to enter the scheme in January 2015. This date has been pushed back until the New Zealand Parliament determines that sufficient technologies are available to reduce emissions in the sector and that international competitors are taking sufficient action on their agriculture emissions.⁶⁹ Participants in the agriculture sector are still required to report their emissions.

Under the NZ ETS, compliance entities are required to obtain and surrender New Zealand Units (NZUs), or other eligible units including international emission units, to account for their direct GHG emissions or the emissions associated with their products. The NZ ETS provides for the transitional free allocation of NZUs to the agriculture sector and certain trade-exposed emission intensive industrial sectors.⁷⁰ The original aim of the NZ ETS was to have full auctioning by all sectors in 2013; however, the allocation of a limited number of free NZUs was extended through amendments in 2012. There are a host of cost control mechanisms in the NZ ETS that have resulted in low prices for NZUs. Most were initially designed to be temporary (or transitional) but have been extended through amendments to the scheme in 2012.⁷¹

- Compliance entities can continue to purchase NZUs at a fixed price of NZ\$25, which effectively serves as a price ceiling, and free allocations of NZUs are given to businesses with emissions-intensive, trade-exposed activities.
- The scheme has extended the measure that allows non-forestry participants to surrender one allowance for every two tonnes of CO₂e (the “one-for-two” surrender obligation), which effectively halves the price of allowances.
- The forestry sector has been given the flexibility to convert land for other use while avoiding NZ ETS deforestation costs by planting a carbon-equivalent area of forest elsewhere, known as “offsetting”.⁷²
- And perhaps most importantly entities can continue to use an unlimited number of international emission units, which has been a main driver in reducing the cost of compliance.⁷³

The revised legislation does not specify an end date for the extended transition measures; however, they are expected to be in place at least until the next NZ ETS review which is

⁶⁹ New Zealand Ministry of the Environment. April 2013. Agriculture in the Emissions Trading Scheme. <http://www.climatechange.govt.nz/emissions-trading-scheme/participating/agriculture/>

⁷⁰ New Zealand Ministry of the Environment. Allocation in the New Zealand Emissions Trading Scheme. <http://www.mfe.govt.nz/publications/climate/allocation-nz-ets-dec07/allocation-nz-ets-dec07.html>

⁷¹ New Zealand Ministry of the Environment. November 2012. 2012 Amendments to the New Zealand Emissions Trading Scheme (NZ ETS): Questions and answers. <http://www.climatechange.govt.nz/emissions-trading-scheme/ets-amendments/questions-answers.html>

⁷² New Zealand Ministry of the Environment. Forestry allocation: NZUs for pre-1990 forest. December 2012. <http://www.climatechange.govt.nz/emissions-trading-scheme/participating/forestry/allocation/>

⁷³ ECOFYS. May 2013.

scheduled for 2015. The result of these measures is that the price of NZUs have dropped from about NZ\$20 (US\$16) in 2011 to about NZ\$2 (US\$1.61) in early 2013. Despite these low prices, the NZETS has made electricity generated from renewable energy a more profitable option for electricity companies in New Zealand. Eleven new renewable power stations totaling 1,340 MW of capacity were constructed in 2010 and 2011. Of those, 59 percent were wind power, 26 percent geothermal, 13 percent hydro, and 2 percent were tidal.⁷⁴ Meanwhile, low NZU prices have limited the expected impact on GDP to between 0.1 and 1.0 percent between now and 2020, depending on the scenario modeled.⁷⁵

5 Carbon Tax

Table 18: Potential Costs and Benefits of a Carbon Tax Policy to Washington Consumers and Businesses

Potential Action for Consideration			
<ul style="list-style-type: none"> Implement a tax on carbon emissions in the state of Washington 			
GHGs and Costs in Washington ⁷⁶	GHG Reductions (MMtCO ₂ e)		Cost (\$/mtCO ₂ e) ⁷⁷
	2020	2035	
\$10 per mtCO₂e tax	0.4	0.6	\$5
\$10, escalating to \$30 per mtCO₂e tax	1.5	2.8	\$15
\$10, escalating to \$50 per mtCO₂e tax	1.7	5.0	\$23
Implementation Issues and Lessons Learned			
<ul style="list-style-type: none"> Emission reductions are highly dependent on the carbon tax rate selected, and the economically efficient rate (the social cost of CO₂) is difficult to estimate. Taxes can be imposed at various cost points, including annual escalation and caps. Policymakers should set these values in advance to provide market certainty, or establish a transparent mechanism to review and adjust rates periodically. Without protections to low-income households, a carbon tax may be regressive. 			

⁷⁴ Climate Spectator. August 2011. <http://www.businessspectator.com.au/article/2011/8/1/carbon-markets/smooth-trading-so-far-so-good-nz-ets#ixzz2bUkaBANI>

⁷⁵ New Zealand Institute of Economic Research. Macroeconomic impacts of the New Zealand Emissions Trading Scheme: A Computable General Equilibrium analysis. March 2011. http://nzier.org.nz/system/files/07.03_BusinessNZ_%20Emissions-2.pdf

⁷⁶ The modeled Carbon Tax considers the impact of a British Columbia-styled carbon tax which applies to the electricity, residential commercial and industrial (RCI), and transportation sectors only. The model assumes that taxes are not applied to industrial process emissions. The model further assumes that aviation and marine fuels are exempt from the carbon tax. Several different carbon tax rates are presented, providing a range of potential GHG impacts and estimates for tax increases and tax revenue generation, as presented in the Quantification section of this report.

⁷⁷ 5 percent discount rate, NPV 2013

- Carbon taxes can generate significant revenue; there are many options for how to use that revenue, including offsetting other taxes or funding additional GHG programs.
- The decision as to which sectors should be exempted, if any, requires consideration of trade-exposure (ability for sectors to move out-of-state or be out-competed by out-of-state firms), potential for cost impacts to be inequitably distributed, and political practicalities.
- Taxes can be collected upstream or downstream, e.g., from fuel producers or fuel consumers

Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
<ul style="list-style-type: none"> • Potential increase in gasoline, residential natural gas, electricity prices • Carbon tax revenue could be used to reduce or offset other types of taxes, including the state property tax, state retail sales tax 	<ul style="list-style-type: none"> • Potential increase in diesel, commercial natural gas price, electricity prices, industrial coal price • Commercial and industrial sector revenue generated from the tax • Carbon tax revenue could be used to reduce business and occupation (B&O) tax

Summary of Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?

Yes. A carbon tax policy would cover all emissions from regulated sectors, economy-wide. While some sectors, such as maritime and aviation fuel consumption for out-of-state and international travel, may be exempt, this provides an opportunity to reduce emissions across the entire economy.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

From 2008 to 2011, BC's per capita GHG emissions associated with carbon-taxed fuels declined by 10 percent. During this period, BC's reductions outpaced those in the rest of Canada by 8.9 percent.⁷⁸ Quantitative volumes were not noted. In absence of all other GHG reduction strategies, the carbon tax alone is estimated to cause reduction in BC's emissions in 2020 by up to 3 MMTCO₂e annually.⁷⁹

In July 2013, one year after the start of the Australia Carbon Pricing Mechanism (CPM), emissions from electricity generation were down over 12 MMTCO₂e, or 6.9 percent.⁸⁰ The Australian CPM has received mixed reviews of success, most recently from the Institute for Energy Research, which claimed in a recent study that the policy caused increases in electricity prices (15 percent), increases in unemployment (10 percent), increased income tax rates for taxpayers, and have actually increased CO₂ levels.⁸¹

A May 2013 CBO report on the effects of a carbon tax in the United States did not directly quantify expected revenue from a carbon tax, but rather referred to analyses on cap-and-trade programs to suggest that a carbon tax that covered the bulk of CO₂ emissions in United States could generate a substantial amount of revenue. The report cited a 2011, CBO study of a nationwide cap-and-trade program that would have set a price of \$20 in 2012 to emit a ton of CO₂ (and increased that price by 5.6 percent each

⁷⁸ Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: <http://www.sustainableprosperity.ca/article3685>

⁷⁹ British Columbia Ministry of Finance: How the Carbon Tax Works. Accessed August 2013 at:

<http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm>

⁸⁰ Ibid.

⁸¹ Robson, A. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. Accessed September 2013 at: http://www.instituteforenergyresearch.org/wp-content/uploads/2013/09/IER_AustraliaCarbonTaxStudy.pdf and associated press release accessed September 2013 here: <http://www.instituteforenergyresearch.org/2013/09/05/deadweight-down-under-australias-carbon-tax/>.

year thereafter), which estimated revenues from the program to be \$1.2 trillion during its first decade. The 2011 report cited also estimated that this cap-and-trade policy would reduce U.S. emissions of CO₂ by about 8 percent over that period than they would be without the policy.⁸²

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

The policy is discrete and comprehensive.

Can the policy be meaningfully implemented or influenced at the State level?

In the absence of a Federal carbon tax, the state can meaningfully implement a policy to charge units of emissions.

5.1 Introduction

Like a cap and trade system, a carbon tax is a market-based mechanism that aims to reduce GHG emissions in a covered geography, sector, or both without prescribing specific methods to achieve those reductions or the ultimate level of emissions for any individual firm. Further, a carbon tax does not provide certainty as to a specific overall level of GHG emissions during any given year or over time. This uncertainty is seen as a principal disadvantage of a carbon tax approach. Conversely, the principal advantage of a carbon tax is that it provides price certainty to the market. This certainty helps policymakers predict economic impacts and helps individuals and firms make the investments necessary and adjust budgets accordingly to prepare for the increased costs of GHG emitting activities.

The most economically efficient carbon tax would be set at an amount equal to the social cost of GHG emissions that are currently not captured in the market and lead to an oversupply of GHG emitting fossil fuels. However, it is very difficult to estimate the social costs of GHG emissions and studies to date have found a wide range of potential costs, even when excluding the tail-end of the distribution of outcomes that would represent an existential threat to humanity.

A more practical approach is to set the tax at an amount that is forecast to yield a particular desired emissions level, as would be achieved under a cap and trade system. However, it is very difficult to predict the magnitude of emission reductions due to the price signals provided by a carbon tax. One of the advantages of the tax, after all, is the flexibility of firms to adjust their emissions to market conditions; reducing emissions when abatement costs are low, and allowing emissions to persist while paying additional taxes when abatement costs are high (e.g., when the price of natural gas compared to coal is peaking).⁸³ This can be addressed by adjusting the tax

⁸² Congress of the United States. Congressional Budget Office. Effects of a Carbon Tax on the Economy and the Environment. May 2013. Page 1. Accessed September 2013 at: http://www.cbo.gov/sites/default/files/cbofiles/attachments/44223_Carbon_0.pdf

⁸³ Center for Climate and Energy Solutions, *Options and Considerations for a Federal Carbon Tax*, February 2013, <http://www.c2es.org/publications/options-considerations-federal-carbon-tax>

periodically (annually or biannually) to achieve the desired level of emission reductions in an iterative process. Unfortunately this approach mitigates the price certainty benefit of carbon taxes and subjects the program to the full range of political uncertainties on an ongoing basis.

The economic efficiency of a carbon tax is not only a function of the price at which it is set, but also the manner in which it is collected. A carbon tax may be collected upstream at petroleum refineries, coal suppliers and gas distribution companies. This has the benefit of a limited number of regulated entities, most with the capacity and experience required for the necessary data collection and administrative activities. Alternatively, the tax may be collected at the end use consumer; when purchasing goods and services, at the gas station, or via utility bills. While this results in a logarithmically larger number of regulated entities, increases administrative costs, and enhances the opportunities for waste and fraud, it offers the substantial benefit of visibility to the consumer that may alter behavior and consumption choices. The costs of a tax collected upstream will naturally filter down to the end-use customer, but may not be visible at all, unless specifically called out on bills or in pricing.

In addition to efficiency concerns, there are distributional impacts to consider when implementing a carbon tax. In their simplest form, carbon taxes are regressive. They will represent a much larger portion of resources available to low income individuals than high income individuals. There are also geographic and sectoral distributional impacts. A carbon tax is likely to create greater burdens in rural areas where miles travel by personal vehicles are considerably higher than in a metropolitan area and much greater burdens in localities dependent on coal-fired electric generation than areas dependent on nuclear or renewable fuels. Similarly, while a carbon tax may benefit the natural gas industry, it will create hardship for coal production companies.

A carbon tax can generate significant revenues. Those revenues can be used to ameliorate some of the negative distributional impacts. This can be accomplished through tax exemptions or refunds for low income individuals and disproportionately affected sectors. In general, the use of carbon revenues to reduce taxes on labor and capital - things we want more of, in contrast to GHG emissions – can help lower the overall economic costs of the program.⁸⁴ There will, of course, be many competing desires for the use of carbon tax revenues. Among these are funds for low-carbon investments in renewable energy and energy efficiency, investments in adaptation to climate change and a virtually limitless list of credible expenditures dependent on political priorities.

⁸⁴Goulder, Lawrence, *Environmental Policy Making in a Second-best Setting*, Economics of the Environment, Selected Readings, 5th ed. Editor R. Stavins, New York, 2005

The use of revenues is far from the only political consideration associated with the implementation of a carbon tax. As with cap and trade, carbon taxes may be applied to all GHG emitting sectors, or may exempt certain sectors. The decision as to which sectors should be exempted, if any, requires consideration of trade-exposure (ability for sectors to move out-of-state or be out-competed by out-of-state firms), potential for cost impacts to be inequitably distributed, and political practicalities. One challenge to the success of a carbon tax program is the inexorable pressure to expand exemptions, reducing both the tax base and the share of emissions subject to abatement.

The majority of work conducted to assess economy-wide GHG policies in Washington has been directed towards cap and trade. However, at both the federal and sub-national levels, carbon taxes have been gaining momentum. Most relevant perhaps, Washington's neighbor to the north – British Columbia – established a carbon tax that has enabled sweeping changes to its tax structure, including significant modifications to reduce income taxes. While income tax is not collected in Washington, the strategy of recycling carbon tax revenue to decrease less popular taxes could be replicated. Section 5.2 below provides a summary of the most comprehensive modeling exercise identified of the impacts of a carbon tax on the Washington economy, which includes a discussion of exempt industries. Next, Section 5.2 summarizes modeling conducted by SAIC using the same model, but considering sensitivity to a number of variables. Finally, section 5.3 provides a brief history of carbon tax implementation in other jurisdictions.

5.2 Literature Review of Washington Potential

In 2011, the Washington State Department of Commerce commissioned a study by University of Washington graduate student Keibun Mori titled “*Washington State Carbon Tax: Fiscal and Environmental Impact*”. The results, methodology, and model were later presented in the article “*Modeling the impact of a carbon tax: A trial analysis for Washington State*” published in the journal *Energy Policy*.⁸⁵ The study used British Columbia's (BC) Carbon Tax policy parameters to quantify the environmental and fiscal impacts of a potential carbon tax in Washington. The primary parameters used in the analysis included:

- A default carbon tax rate of \$10/mtCO₂e increasing at \$5/mtCO₂e per year and capped at \$30/mtCO₂e.⁸⁶ [Based on his findings, Mori recommended that the cap for Washington State be \$70/ mtCO₂e].
- All carbon tax revenues are cycled back into the economy in the form of income and business tax credits.

⁸⁵ Mori. 2012. Modeling the impact of a carbon tax: A trial analysis for Washington State. *Energy Policy*. (June 28, 2012). Accessed August 2013 at: <http://www.sciencedirect.com/science/article/pii/S0301421512004806>

⁸⁶ Mori. 2011. *Washington State Carbon Tax: Fiscal and Environmental Impacts*. Page 6. Accessed August 2013 at: <http://www.commerce.wa.gov/Documents/Washington-State-Carbon-Tax.pdf>

- Exemptions included for aviation and maritime fuel for interstate and international trips.
- The study pulled elasticity estimates for various fuel types, and provided a weighted average value for various fuels, as summarized in Table 19.⁸⁷ The price elasticity of demand estimates the effect of price changes on demand for fuels.

Table 19: Weighted Price Elasticities of Demand for Various Fuel Types [from Mori, 2011]

Sector	Fuel Type	Price Elasticity of Demand
Transportation	Gasoline	-0.62
	Diesel Fuel	-0.44
	Jet Fuel	-0.23
	Residual Fuel	-0.37
Residential	Electricity	-0.43
	Natural Gas	-0.38
Commercial	Electricity	-0.47
	Natural Gas	-0.35
Industrial	Electricity	-0.49
	Natural Gas	None estimated

The study concluded that implementing a carbon tax could help Washington meet the revised goals of the State Energy Strategy that include maintaining competitive energy prices, fostering a clean energy economy and jobs, and meeting obligations to reduce GHG emissions.⁸⁸ In order to work toward reducing emissions to 1990 levels by 2035, the study concluded that a carbon tax would need to start at \$10/mtCO₂e in year one, increase by \$5/mtCO₂e per year, and be capped at \$70/mtCO₂e (\$0.70 per gallon of gasoline).⁸⁹ The tax rate of \$70/mtCO₂e assumes the State would also implement other policies to reduce emissions to reach its 2035 goal of 25 percent below 1990 levels by 2035. Based on his findings, Mori offered the following recommendations for implementing a carbon tax in Washington:⁹⁰

- Identify a carbon tax rate that provides explicit price information on future energy costs.
- Coordinate complementary policies, such as policies that target non-point source emissions.
- Duplicate the British Columbia exemptions for jet and marine fuel to ease oppositions from the freight industry and mitigate the potential leakage of demand for air and marine travel.

⁸⁷ Mori, 2011. Table 6, Page 24.

⁸⁸ Mori. 2011. Pages 8 and 43.

⁸⁹ Mori. 2011. Page 6.

⁹⁰ Mori. 2011. Pages 43-44.

- Design a fair and reliable revenue recycling mechanism to maintain economic competitiveness by offsetting the financial burden of the carbon tax.

Critics of a carbon tax in other jurisdictions, particularly British Columbia, have voiced concerns that the tax creates incentives for some businesses to reduce output or shift production and investment to other locations where energy taxes are lower. In British Columbia, the carbon tax paid by all businesses exceeds the revenues they save from the lower business tax rates. Additionally, critics charge that consumers, along with truckers and commercial vehicles, purchase fuels across the U.S. border where fuel prices are cheaper.⁹¹

In his analysis, Mori modeled the Washington carbon tax after BC's carbon tax, such that it would be implemented at \$10/mtCO₂e in year one and increased annually by \$5/mtCO₂e per year until reaching a maximum of \$30/mtCO₂e. Based on these rates, Mori estimated that the \$30/mtCO₂e tax would generate roughly \$2.1 billion in revenues for the state, and would reduce GHG emissions by 8.4 percent, or 7 MMTCO₂e, from a business as usual approach by 2035.⁹² In order to meet Washington's GHG target, Mori recommended a tax rate of \$70/mtCO₂e to reduce GHG emissions by 16 percent, or 13.3 MMTCO₂e.

In British Columbia, tax revenue was used to offset income tax. However, as Washington does not have an income tax, the analysis instead assumed that the carbon tax revenues would be used to offset Washington's major tax revenue sources – retail sales tax and property tax for individuals and the business and occupation (B&O) taxes for businesses.⁹³ According to Mori, consumers eventually bear all the increased costs from the carbon tax through increased costs of final products from manufacturers. This cost could be partially offset by returning the carbon tax revenues to consumers in the form of tax credits.⁹⁴

Modeling showed that a carbon tax would slow the growth of industries that emit large amounts of CO₂, but boost other industries in clean energy. Additionally, implementation of a carbon tax has the potential to slightly reduce economy-wide employment due to the lower demand for workers in carbon-intensive industries and weakened incentives for labor force participation.⁹⁵

Mori found that many of the costs and benefits of a Washington revenue-neutral carbon tax policy would be similar to those observed in the BC Carbon Tax policy. British Columbia and Washington are geographically contiguous and share many socioeconomic characteristics,

⁹¹ The Vancouver Sun. 2013. *B.C.'s carbon tax hurting businesses*. Accessed at 2013: <http://www.vancouversun.com/business/bc2035/carbon+hurting+businesses/8739247/story.html>

⁹² Mori. 2011. Table 1, Page 5.

⁹³ Mori, 2011.

⁹⁴ Mori, 2011.

⁹⁵ Resources for the Future. *Considering a Carbon Tax*. Accessed August 2013 at: http://www.rff.org/centers/climate_and_electricity_policy/Documents/carbon-tax-FAQs.pdf

including fuel mix of electricity generation, land use patterns, economic structure, and dependence on international trade. These similarities enable a relevant comparison of forecasted and actual effects of the British Columbia carbon tax, to forecasted effects in Washington.⁹⁶

The majority of Washington's energy production comes from hydropower. In 2012, hydropower made up 69.5 percent of Washington's aggregate fuel mix, where coal power made up 13.4 percent and natural gas made up 11.0 percent of the aggregate fuel mix.⁹⁷ No cost increase is expected for hydropower. At a cost of \$30/mtCO₂e, the carbon tax is expected to increase the cost of industrial natural gas by 16.9 percent and coal by 79.4 percent.⁹⁸ The increase in the cost of electricity production from emissions-intensive generation facilities has the potential to be passed down to consumers. If the carbon tax is set at too high a rate, energy production in these sectors has the potential to move out of state, though this would likely have minimal impact on Washington's predominantly hydro-powered generation.

One strategy to mitigate future impacts is to provide explicit information on future energy costs, as it is likely to prompt consumers and businesses to invest in energy-saving technologies and therefore maximize the effect of the carbon tax.⁹⁹ In British Columbia, analysts determined the carbon tax is still too low in terms of price to drive a shift to new low-carbon practices and technologies.¹⁰⁰

A carbon tax has the potential to cause leakage, or a shift of Washington's GHG emissions to other jurisdictions. This would occur as the carbon tax alters the relative price of fuels, and with it alters the economics of operating in Washington. Depending on the interaction between these costs and tax adjustments resulting from carbon tax revenue, this could cause adverse impacts on overall production activities, particularly on energy-intensive industries such as refining and metal manufacturing. Mori cites a report by Morgenstern et al (2007) that found a carbon tax at \$10/mtCO₂e would reduce output by less than 1 percent for most industries near-term in the US, but will be greater for industries such as vehicle manufacturing (1 percent), chemicals and plastics (1 percent), and primary metals (1.5 percent).¹⁰¹ A revenue recycling scheme to

⁹⁶ Ibid.

⁹⁷ Washington State Department of Commerce. 2013. *Washington State Electric Utility Fuel Mix Disclosure Reports for Calendar Year 2012*. Accessed August 2013 at: <http://www.commerce.wa.gov/Documents/Utility-Fuel-Mix-Reports-Data-CY2012.pdf>

⁹⁸ Mori. 2012. Modeling the impact of a carbon tax: A trial analysis for Washington State. *Energy Policy*. (June 28, 2012). Accessed August 2013 at: <http://www.sciencedirect.com/science/article/pii/S0301421512004806>

⁹⁹ Mori. 2011. *Washington State Carbon Tax: Fiscal and Environmental Impacts*. Accessed August 2013 at: <http://www.commerce.wa.gov/Documents/Washington-State-Carbon-Tax.pdf>

¹⁰⁰ Sustainable Prosperity. *British Columbia Carbon Tax Review*. September 2012. Accessed August 2013 at: <http://www.sustainableprosperity.ca/dl891&display>

¹⁰¹ Morgenstern, et. al. Competitiveness Impacts of Carbon Dioxide Pricing Policies on Manufacturing. *Assessing US Climate Policy Options*. November 2007. Resources for the Future. Pages 96-105. Accessed September 2013 at: http://rff.org/RFF/Documents/CPF_COMPLETE_REPORT.pdf

offset tax revenues with the emphasis on low-income households and energy-intensive industries can mitigate the concerns on income equity and leakage problems.¹⁰²

5.3 Quantification

This section presents updated analytical results on the impact of a potential carbon tax on Washington's GHG emissions and revenue potential. It builds on the analysis performed by Mori in 2011, utilizing an updated version of the model provided by the author and Washington State. The model considers the impact of a British Columbia-styled carbon tax which applies to the electricity, residential commercial and industrial (RCI), and transportation sectors only. The model assumes that taxes are not applied to industrial process emissions. The model further assumes that aviation and marine fuels are exempt from the carbon tax.

Several different carbon tax rates are presented, providing a range of potential GHG impacts and estimates for tax increases and tax revenue generation. This analysis does not engage the political question of how those revenues might be used. Options include alterations to the tax code, as done in British Columbia, use of revenue as seed funding for a PACE program (discussed in Section 10 of this report), use as a PBF-type fund (discussed in Section 10 of this report) as done with RGGI auction revenues, or myriad other options.

5.3.1 Methodology

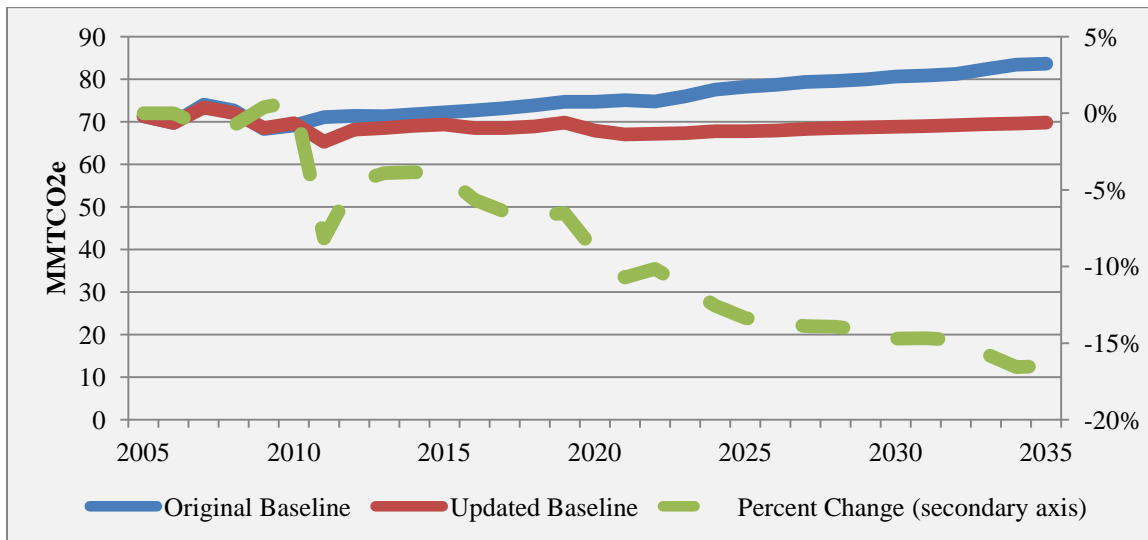
As the most robust, Washington-specific carbon tax model available, this analysis utilizes the C-TAM model created by Mori and staff at the Washington Department of Commerce. The original model, documented in Section 5.2, utilized then-current data to project baseline fuel consumption and costs. For this analysis, an updated model was obtained, version 2.2, which incorporates important changes to these baseline data. The version of the model used here utilizes reference case data from the EIA's Annual Energy Outlook 2013. Importantly, use of the AEO 2013 data means that the baseline case against which the model quantifies emission reductions, already includes emission reductions from existing federal policies including those evaluated in Task 3.

The general impact of the update to the model was to decrease projected baseline emissions. As shown in Figure 3, the update to AEO input data causes a reduction in 2035 baseline emissions of almost 14 MMTCO₂e, or over 16 percent. This is due to the inclusion of additional federal policies enacted since C-TAM's original issuance, including the new light-duty vehicle GHG and CAFE standards for model years 2017-2025, among others. This update is important to recognize, because while the results generated from the updated model will generally show lower

¹⁰² Sustainable Prosperity. September 2012.

overall magnitude emission reductions, absolute emissions will be lower than in previous modeling.

Figure 3. Change in baseline projection between C-TAM base model and update including AEO 2013.



C-TAM is an elasticity-based model which projects GHG emission changes based on changes in fuel consumption across various sectors. In response to the change in price of these fuels that results from inclusion of a carbon premium equal to the per unit GHG emissions multiplied by the carbon tax, the model applies an elasticity factor to calculate emission changes. Essentially, this means that as total prices (base fuel price plus carbon tax) go up, consumption and with it GHG emissions will go down. The magnitude of this change is different for each fuel, based on a fuel-specific elasticity value which roughly corresponds to price sensitivity.

The model also includes an option, utilized in this analysis, which enables the electricity sector to choose alternate fuels in response to the imposition of a carbon tax. In essence, this means that rather than simply reducing the use of fuels and therefore consumption, the fuel mix itself may adjust to the new relative expense of feedstocks resulting from a carbon tax.

In addition to estimating changes in GHG emissions, this analysis also provides a summary of tax generation by sector, and in total. These taxes come as a cost to businesses and individuals, but as revenue to the State. Therefore, two different approaches were pursued to estimate the cost effectiveness of the carbon tax under each tax rate.

Cost of Tax Method: The cost of tax method treats all taxes as costs. Total tax generation from the program's modeled inception in 2015 through 2035 are summed to a net present value in 2013. This value is then divided by the total number of emissions reductions achieved over this same period from 2015 to 2035. The cost of tax method will result in a higher estimated cost

effectiveness because it assumes all taxes are net costs and does not account for the subsequent spending of that tax revenue by the State.

Marginal Abatement Method: The marginal abatement method follows the economic principle that emitters whose costs of reducing emissions are above the tax rate will elect to pay the tax, and that those whose emissions are below the tax rate will choose to reduce their emissions. Accordingly, the marginal, most expensive GHG reduction that should occur under this system is a reduction equal to the tax rate. To estimate cost effectiveness, annual costs were calculated as the product of the tax rate and total emissions, then summed from 2015 to 2035 to a net present value in 2013. As with the previous method, this cost was then divided by the total number of emissions reductions achieved over the same period from 2015 to 2035.

Although the cost of tax method is a seemingly more intuitive approach, the marginal abatement method should more accurately reflect the impact to the State's economy as a whole.

5.3.2 Assumptions, Exclusions, and Data Sources

Most notably, this analysis relies on the C-TAM model and its various assumptions, elasticities, and methods documented in Mori 2011. In addition, this analysis applies the following assumptions:

- All assumptions implicit in C-TAM version 2.2
- The carbon tax is first imposed in 2015
- The first-year carbon tax rate is \$10 per metric ton CO₂e, and escalates to various levels by \$5 annually in each model run
- A carbon tax results in a change to the electric fuel mix as relative prices of fuels change
- The tax is applied to the electricity, RCI, and transportation sectors
- All aviation fuel and marine fuels are exempted
- Baseline fuel consumption and cost are derived from the AEO 2013, and prorated for Washington from the Pacific region
- Base costs of fuels do not change as a result of the carbon tax. It is possible that producers and distributors of fossil fuels would reduce operating margins and costs to maintain market share

The primary data sources used in this analysis include:

Data	Source
Energy forecasts	AEO 2013
Energy prices	AEO 2013
Additional model data including GHG emission factors, WA tax rates and revenues, and price	C-TAM version 2.2

elasticity of demand.

5.3.3 Results

Three carbon tax rates of \$10, \$30, and \$50 per metric ton CO₂e were analyzed. The tax rate in all three scenarios began at \$10 per metric ton CO₂e and escalated \$5 per year to reach these levels. C-TAM modeling with these parameters estimated emission reductions ranging from 0.9 to 5.4 MMTCO₂e in 2020, and 1.1 to 8.1 MMTCO₂e in 2035, depending on the tax rate specified. These reductions are the result of decreased energy use ranging from 20.4 to 85.72 billion Btus in 2020, and 30.2 to 135.9 billion Btus in 2035. Summary results are provided in Table 20.

Table 20. Change in GHG emissions, tax revenue, and energy consumption under three carbon tax rates.

	2020			2035		
Tax Rate	\$10	\$30	\$50	\$10	\$30	\$50
Change in GHG Emissions (MMTCO ₂ e)	0.4	1.5	1.7	0.6	2.8	5.0
Change in Taxes and Tax Revenue (million US\$)	\$563	\$1,656	\$1,922	\$571	\$1,646	\$2,635

As shown in Figure 4, emission reductions are proportional to the magnitude of the carbon tax applied due to linear price elasticities. In the base case, emissions are the greatest, and in each model run reflecting higher carbon tax rates, emissions decrease. Emissions are lowest under a modeled \$50 carbon tax; yet higher tax rates would generate even deeper GHG reductions.

Figure 4. Washington emissions from the energy sector in the base case and three carbon tax rates.

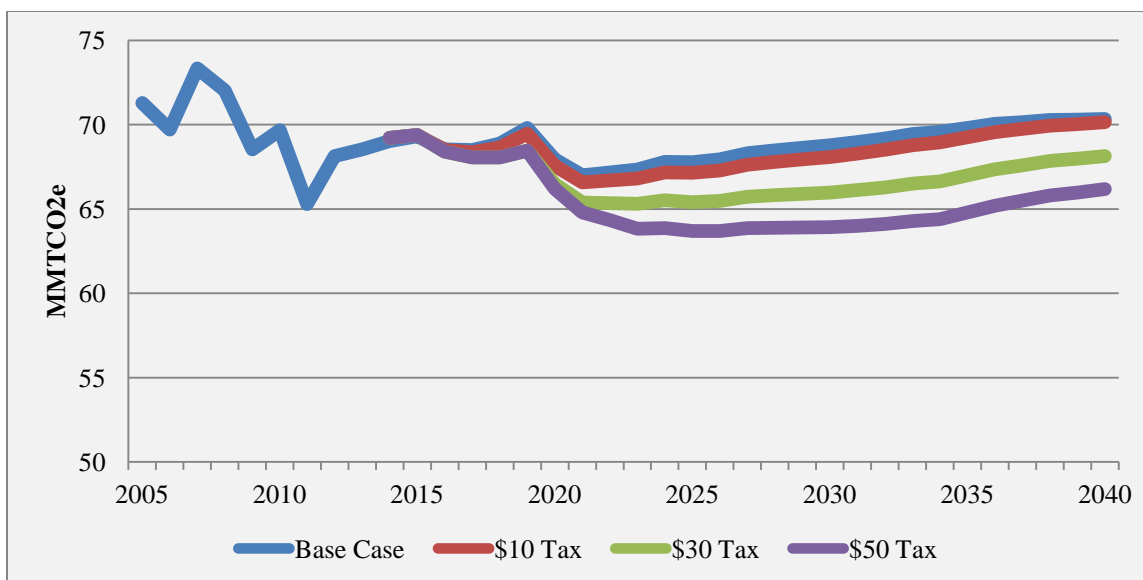


Table 21, Table 22, and Table 23 provide summary information on the three modeled carbon tax rates of \$10, \$30, and \$50 per metric ton CO₂e in 2020 and 2035. The GHG emission reductions are the result of increased prices to carbon-intensive fossil fuels, and the GHG reductions generally correspond to a decrease in fossil fuel energy consumption. In addition to the impact on GHG reductions, these figures also provide results on the taxes generated from the residential, commercial, industrial, and transportation sectors. In all three carbon tax rates modeled, the largest share of tax was generated from the transportation sector, though GHG emission reductions from this sector are proportionally smaller. This is a result of a relatively low price elasticity of demand in the transportation sector compared to the residential, commercial, and industrial sectors.

Table 21, Table 22, and Table 23 also provide total tax revenues collected in each target year for each tax rate. A carbon tax of \$10 per metric ton CO₂e could generate \$563 million, and a carbon tax of \$50 per metric ton CO₂e could generate 1.9 billion in 2020. With 2012 taxes totaling \$17.6 billion, this translates to enough revenue to offset between 3 and 11 percent of Washington's existing tax collection.

In addition to the annual tax revenue and GHG reductions, Table 21, Table 22, and Table 23 provide cumulative tax revenue and GHG reductions from inception in 2015 through 2035. Cumulative GHG reductions range from 10.4 MMTCO₂e with a \$10 per metric ton CO₂e tax, to 69.2 MMTCO₂e when the tax is allowed to rise to \$50 per metric ton CO₂e. Finally, each table provides an estimate of the cost effectiveness of the carbon tax using both the cost of tax method and the marginal abatement method. Cost effectiveness using the cost of tax method ranges from \$341 to \$634 per metric ton CO₂e. Cost effectiveness according to the marginal abatement method is \$5 to \$23 per metric ton CO₂e. Based on the cost of tax method, cost effectiveness increases as the maximum carbon tax rate rises. This is due to the fact that higher taxes

incentivize greater abatement and result in fewer taxed emissions. Conversely the cost effectiveness according to the marginal abatement method decreases as the tax rate increases. This occurs because each reduction that occurs is assumed to have a cost equal to the higher tax rate. Although both methods are presented for completeness, the marginal abatement method more appropriately reflects the true cost effectiveness of a carbon tax.

Table 21. GHG emission reductions and taxes resulting from a constant \$10 per metric ton CO₂e tax, by sector

Sector	2020		2035		2015-2035	
	GHG Emission Reductions (MMTCO ₂ e)	Tax Revenue (million \$USD)	GHG Emission Reductions (MMTCO ₂ e)	Tax Revenue (million \$USD)	GHG Emission Reductions (MMTCO ₂ e)	NPV Tax Revenue (million \$USD) ^a
Residential	0.1	\$76	0.2	\$78	2.7	903
Commercial	0.1	\$72	0.3	\$82	3.2	923
Industrial	0.4	\$104	0.6	\$105	10.2	1,213
Transportation	0.3	\$312	0.3	\$306	6.3	3,583
Totals	0.4	\$563	0.6	\$571	10.4	6,577
Cost per ton CO ₂ e (cost of tax method)					\$634	
Cost per ton CO ₂ e (marginal abatement method)					\$5	

^a 5 percent discount rate, NPV in 2013

Table 22. GHG emission reductions and taxes resulting from a \$10 per metric ton CO₂e tax which escalates by \$5 annually to a \$30 carbon tax, by sector

Sector	2020		2035		2015-2035	
	GHG Emission Reductions (MMTCO ₂ e)	Tax Revenue (million \$USD)	GHG Emission Reductions (MMTCO ₂ e)	Tax Revenue (million \$USD)	GHG Emission Reductions (MMTCO ₂ e)	NPV Tax Revenue (million \$USD) ^a
Residential	0.2	\$222	0.6	\$223	7.7	2,301
Commercial	0.3	\$210	0.8	\$231	9.1	2,345
Industrial	0.7	\$304	1.3	\$296	18.6	3,088
Transportation	0.8	\$920	1.0	\$897	18.6	9,284
Totals	1.5	\$1,656	2.8	\$1,646	42.0	16,907
Cost per ton CO ₂ e (cost of tax method)					\$403	
Cost per ton CO ₂ e (marginal abatement method)					\$15	

^a 5 percent discount rate, NPV in 2013

Table 23. GHG emission reductions and taxes resulting from a \$10 per metric ton CO₂e tax which escalates by \$5 annually to a \$50 carbon tax, by sector

Sector	2020		2035		2020-2035	
	GHG	Tax Revenue	GHG	Tax Revenue	GHG	NPV Tax

	Emission Reductions (MMTCO ₂ e)	(million \$USD)	Emission Reductions (MMTCO ₂ e)	(million \$USD)	Emission Reduction s (MMTCO ₂ e)	Revenue (million \$USD) ^a
Residential	0.3	\$258	1.0	\$352	12.0	3,189
Commercial	0.3	\$243	1.2	\$362	14.2	3,245
Industrial	0.7	\$352	1.9	\$461	25.9	4,255
Transportation	0.9	\$1,069	1.7	\$1,460	29.1	13,049
Totals	1.7	\$1,922	5.0	\$2,635	69.2	23,582
Cost per ton CO ₂ e (cost of tax method)					\$341	
Cost per ton CO ₂ e (marginal abatement method)					\$23	

^a 5 percent discount rate, NPV in 2013

5.4 Implementation History

British Columbia, Canada: On July 1, 2008, British Columbia (BC) implemented the BC Carbon Tax Act, the first carbon tax policy in North America. The BC carbon tax imposes a price on the use of carbon-based fuels, including gasoline, diesel, jet fuel, natural gas, propane, and coal. BC's carbon tax was designed to be "revenue neutral," as all revenue generated by the tax is used to reduce other taxes – mainly through cuts to income taxes (personal and corporate), as well as targeted tax relief for vulnerable households and communities, resulting in no overall increase in taxation. The tax covers three quarters (77 percent) of the province's GHG emissions from residential, commercial, and industrial sources. The measure is a central component of BC's climate change strategy that aims to reduce GHG emissions by 33 percent below 2007 levels by 2020.¹⁰³

When introduced in 2008, the BC carbon tax was set at CAD\$10 (US\$9.68) per mtCO₂e. It was designed to rise by CAD\$5 (US\$4.84) per year thereafter until it reached CAD\$30 (US\$29.04) per mtCO₂e in 2012. Since different fuels generate different amounts of GHGs when burned, the CAD\$30 (US\$29.04) per mtCO₂e is translated into tax rates for specific fuel types. For example, the current rate for a liter of gasoline is CAD\$0.0667 (US\$0.227/gallon) and the current rate for a liter of diesel is CAD\$0.0767 (US\$0.265/gallon).¹⁰⁴

According to the BC Ministry of Finance, the revenue-neutral carbon tax is based on the following principles¹⁰⁵:

¹⁰³ Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: <http://www.sustainableprosperity.ca/article3685>

¹⁰⁴ British Columbia Ministry of Finance: What is the Carbon Tax?. Accessed August 2013 at: <http://www.fin.gov.bc.ca/tbs/tp/climate/A1.htm>

¹⁰⁵ British Columbia Ministry of Finance. Tax Cuts Funded by the Carbon Tax. Accessed August 2013 at: <http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm>

- **All carbon tax revenue is recycled through tax reductions.** The government has a legal requirement to present an annual plan to the legislature demonstrating how all the carbon tax revenue will be returned to taxpayers through tax reductions. The money will not be used to fund government programs.
- **Allow time to adjust.** The tax rate started low and increased gradually to allow individuals and businesses time to adjust.
- **Protect low-income individuals and families.** Low-income individuals and families are protected through a refundable Low Income Climate Action Tax Credit designed to offset the carbon tax.
- **The tax has the broadest possible base.** Virtually all emissions from fuel combustion in BC captured by Environment Canada's National Inventory Report are taxed, with no exceptions except those required for integration with other climate action policies in the future and for efficient administration.
- **The tax will be integrated with other measures.** The carbon tax will not, on its own, meet BC's emission-reduction targets, but it is a key element in the strategy. The carbon tax and complementary measures such as "cap and trade" system will be integrated as other measures are designed and implemented.

The tax puts a price on carbon to encourage individuals, businesses, industry, and others to use less fossil fuel and reduce their GHG emissions. In addition, it sends a consistent price signal, ensuring that those who produce emissions pay for them, and makes clean energy alternatives more competitive.¹⁰⁶ According to Sustainable Prosperity, the majority of energy and carbon intensive industries in Canada are overwhelmingly in favor of a price on carbon, but there is no consensus on the pricing mechanism.¹⁰⁷

From 2008 to 2011, BC's per capita GHG emissions associated with carbon-taxed fuels declined by 10 percent. During this period, BC's reductions outpaced those in the rest of Canada by 8.9 percent.¹⁰⁸ Quantitative volumes were not noted. In absence of all other GHG reduction strategies, the carbon tax alone is estimated to cause reduction in BC's emissions in 2020 by up to 3 MMTCO₂e annually.¹⁰⁹

Australia: Under Australia's Carbon Pricing Mechanism (CPM), which took effect in July 2012, liable entities must surrender one carbon unit for every metric ton of CO₂e they emit in each

¹⁰⁶ British Columbia Ministry of Finance: Carbon Tax Review, and Carbon Tax Overview. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm

¹⁰⁷ Sustainable Prosperity. Canadian Business Preference on Carbon Pricing. January 2011. Accessed August 2013 at: <http://www.sustainableprosperity.ca/dl329&display>

¹⁰⁸ Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: <http://www.sustainableprosperity.ca/article3685>

¹⁰⁹ British Columbia Ministry of Finance: How the Carbon Tax Works. Accessed August 2013 at: <http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm>

subject year. The CPM covers approximately 60 percent of Australia's emissions and includes emissions from electricity generation, stationary energy, landfills, wastewater, industrial processes, and fugitive emissions, but does not cover agricultural or transportation emissions.¹¹⁰ Entities in regulated sectors are subject to the CPM if they operate subject facilities with direct (scope 1) emissions that exceed 25,000 mtCO₂e per year.¹¹¹ Although households, businesses use of light-duty vehicles and the agriculture, forestry and fishery industries do not pay a carbon price for transport fuel under the CPM, these sectors will continue to pay a transport fuel excise tax. Emissions from certain business transport fuels, such as rail and shipping, are also subject to an effective carbon price through changes to the tax structure that result in a price equivalent to a carbon price on these emissions.¹¹²

The CPM was structured to begin effectively as a carbon tax (fixed price) and transition later to a cap and trade system (flexible price). Initial designs called for a gradually increasing fixed price for carbon for each of the first three years of implementation (July 2012 to July 2015), then a transition to a flexible-price scheme in July 2015, when the price of carbon units would be set by the market. However, the Australian Government announced in July 2013 that it has planned to move up the start date of the flexible-price scheme to July 2014, one year earlier than expected. The limit on emissions, known as the "pollution cap", in the first year of the flexible-price period will be set once the relevant legislation is amended to make 2014-2015 the first flexible-price year. Until then, the existing default pollution cap will be extended to 2014-2015.

The Australian Government estimated that Australia's per capita emissions were around 25 mtCO₂e in 2012, and were projected to increase to 27 mtCO₂e in 2030 without the CPM. With the CPM, per capita emissions are projected to be 21 mtCO₂e in 2030 with domestic abatement only, and 13 mtCO₂e with domestic and international abatement included.¹¹³ In July 2013, one year after the start of the CPM, emissions from electricity generation were down over 12 MMTCO₂e, or 6.9 percent.¹¹⁴ The Australian CPM has received mixed review of success, most recently from the Institute for Energy Research, which claimed in a recent study that the policy caused increases in electricity prices (15 percent), increases in unemployment (10 percent), increased income tax rates for taxpayers, and have actually increased CO₂ levels.¹¹⁵

¹¹⁰ Australian Government Clean Energy Regulator: About the carbon pricing mechanism. Accessed July 2013 at: <http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/About-the-Mechanism/Pages/default.aspx>

¹¹¹ Ibid.

¹¹² Australian Government. Transport Fuels. <http://www.cleanenergyfuture.gov.au/transport-fuels/>

¹¹³ Australian Government. How Australia's Carbon Price is Working One Year On. July 2013. <http://www.cleanenergyfuture.gov.au/wp-content/uploads/2013/08/carbon-price-one-year-on.pdf>

¹¹⁴ Ibid.

¹¹⁵ Robson, A. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. Accessed September 2013 at: <http://www.instituteforenergyresearch.org/wp->

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[content/uploads/2013/09/IER_AustraliaCarbonTaxStudy.pdf](http://www.instituteforenergyresearch.org/wp-content/uploads/2013/09/IER_AustraliaCarbonTaxStudy.pdf) and associated press release accessed September 2013 here: <http://www.instituteforenergyresearch.org/2013/09/05/deadweight-down-under-australias-carbon-tax/>.

¹¹⁶ Ibid.

¹¹⁷ Robson, A. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. Accessed September 2013 at: http://www.instituteforenergyresearch.org/wp-content/uploads/2013/09/IER_AustraliaCarbonTaxStudy.pdf and associated press release accessed September 2013 here: <http://www.instituteforenergyresearch.org/2013/09/05/deadweight-down-under-australias-carbon-tax/>.

6 Reducing Vehicle Miles Traveled (VMT)

Transportation sources generate more GHG emissions than any other sector in the State. This is not the result of an abnormally inefficient transportation system; nor is the car culture more pervasive among Washington residents than the rest of Americans. The transportation sector's lead ranking in statewide GHG emissions has the most to do with the abundance of hydropower, which provides a large share of the state's electricity and results in a relatively low-GHG profile for the electric power and RCI sectors. In fact, on a per-capita basis, on-road gasoline and diesel fuel consumption has been consistently among the lowest in the region for at least the past decade, as Washington drivers consume less than their counterparts in Oregon, Idaho, and Montana, although more than Californians.¹¹⁸ Still, given that transportation sector accounts for nearly half of the State's GHG emissions, specifically 44 percent of total GHG emissions in 2010, the State is unlikely to achieve the GHG emissions reductions it has targeted in its statute without a significant decrease in transportation emissions.

There are many transportation emission-reduction strategies, which can be grouped into the four categories of vehicle improvements, fuel switching, system efficiency, and demand reduction. For this project, several policies that require or incentivize next-generation technologies in vehicles and fuels were analyzed in depth, including ZEV, LCFS, and RFS and biofuels support. Some indicate technology-based strategies are more cost-effective than VMT strategies.¹¹⁹

In addition to policies targeting vehicles and fuels, there are a large number of policy approaches and program strategies that seek improvements in overall transportation system efficiency and VMT reductions. Many VMT-reduction strategies have been evolving in practice around the world in various forms and for a variety of purposes, for decades. Examples include carpooling, public transportation options, roadway pricing, and comprehensive land-use planning requirements. This is one reason that more VMT policies were not analyzed in greater depth under Task 2 of this project – in general, the most successful and essential VMT-reduction strategies are already in place in Washington, and thus not the focus of the Task 2 scope. Transportation and environmental professionals recognize that there is no 'silver bullet' for the transportation sector, and thus the State already has a host of effective programs that continue to generate benefits, whatever their primary objective might be. For as long as there has been traffic congestion, communities and governments have sought congestion relief – because congestion contributes more than GHG emissions, but also air quality pollutants, fuel costs, foreign oil dependency, and delays in time which causes frustration, lost revenue, and a

¹¹⁸ U.S. Energy Information Administration, State Energy Data System (SEDS), as summarized by SAIC in Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State, Task 1.a – Analyze Washington State's total consumption and expenditures for energy, 2013.

¹¹⁹ American Association of State Highway and Transportation Officials (AASHTO) Primer on Transportation and Climate Change, April 2008, accessed September 2013 at <http://downloads.transportation.org/ClimateChange.pdf>

disruption of goods movements to markets. The programs have fallen under categories mirroring the most pressing problems of the time – from air quality attainment under the Clean Air Act, to congestion relief. The flip side highlights the many co-benefits of transportation GHG emission-reduction strategies to reduce VMT: saving time and money, enhancing livability, reducing energy use and foreign oil dependence, and improving air quality, which provides health benefits.

The challenge with policies that target demand reduction is that they often require a behavioral shift, for example to telework rather than commuting into work, or to take a bus or bike instead. People make daily choices about whether and how to make a trip, considering cultural, economic, environmental, and social factors. Elasticity data have long shown that Americans' demand for travel is relatively inelastic. As gasoline prices rise, people are more likely to change cars than change driving habits – price affects vehicle choice more than VMT.¹²⁰ Historically, VMT closely tracks the economy and personal income, and has grown at roughly 2.5 percent per year.¹²¹ American Association of State Highway and Transportation Officials (AASHTO) asserts that some VMT growth is in fact necessary to accommodate population and economic growth, including freight transport, although recommends the nation work toward an overall reduction in the *rate of growth* in nationwide VMT down to about one percent per year,¹²² which will require a reduction in per capita VMT.

New research suggests that the many varied VMT-targeting policies, many of which have demonstrated successes at a program level (e.g., Washington State's Commute Trip Reduction Program)¹²³, may be having a strong macro effect, actually changing the trajectory of the VMT trendline. "Per person, per driver, and per household—we now have fewer light-duty vehicles and we drive each of them less than a decade ago." The peak occurred several years prior to the start of the economic recession; therefore the author attributes the reduction to "other societal changes that influence the need for vehicles (e.g., increases in telecommuting and in the use of public transportation)."¹²⁴ Driving in Oregon also *may* have peaked in 2004 – a traffic data analysis by *the Oregonian* demonstrates a changing trend that mirrors the national numbers.¹²⁵

¹²⁰ Moving Cooler: *Transportation Strategies to Reduce Greenhouse Gas Emissions*, June 2009.

¹²¹ American Association of State Highway and Transportation Officials (AASHTO) Primer on Transportation and Climate Change, April 2008, accessed September 2013 at <http://downloads.transportation.org/ClimateChange.pdf>

¹²² American Association of State Highway and Transportation Officials (AASHTO) Primer on Transportation and Climate Change, April 2008, accessed September 2013 at <http://downloads.transportation.org/ClimateChange.pdf>

¹²³ State of Washington Department of Commerce, Energy Strategy, 2012 Washington State Energy Strategy, 2011, accessed September 2013 at <http://www.commerce.wa.gov/Documents/2012WASateEnergyStrategy.pdf>.

¹²⁴ Michael Sivak, Has Motorization in the U.S. Peaked? Part 2: Use of Light-Duty Vehicles. University of Michigan, Transportation Research Institute, UMTRI-2013-20. July 2013. Accessed September 2013 at <http://deepblue.lib.umich.edu/bitstream/handle/2027.42/98982/102950.pdf>

¹²⁵ Joseph Rose, Drivers ease off the gas in cultural shift, the Sunday Oregonian, September 15, 2013.

These historical patterns, which are reflected in Washington as well,¹²⁶ likely would not have occurred if it were not for the effective implementation of bundles of travel demand management programs and investments, including pricing strategies, trip reduction programs, and transportation alternatives.

Dozens of potential policies targeting system efficiency and VMT reductions could have been identified for further consideration under Task 2 of this project, but the list of all possible policy approaches was narrowed to the following based on the criteria established in Section 3, and given that many policies and programs already exist and are being successfully implemented in Washington currently.

- Mileage Based User Fee (MBUF)
- Pay-As-You-Drive Insurance (PAYD)
- Significant New Investment in Public Transit

A discussion of MBUF and PAYD are included in this final report. Although quantification was not prepared based on the limited information available on these approaches as a GHG reduction strategy, the MBUF policy, which is gaining traction around the country for revenue generation as a gas tax replacement, could have strong potential as a GHG strategy given thoughtful design and implementation. The CLEW may consider whether further evaluation is desired under Task 5. Public transit also provides an important role within the overall efficiency of the transportation system, and synergistic effects when new investments are implemented in coordination with other transportation and land-use strategies. However, current research and communications with State agency staff resulted in the determination not to conduct additional quantitative evaluation, because given foreseeable funding levels even if moderate increases are approved, the magnitude of emissions reductions achievable for changes to transit policy are small relative to other policies evaluated in depth under Task 2. Related to transit investments, Compact Transit-Oriented Development (CTOD) land-use patterns are reportedly associated with significant GHG emission reductions. CTOD is discussed and its potential GHG reductions quantified under Task 1, within the evaluation of the Growth Management Act (GMA).

¹²⁶ Data show a short-term peak and decline through the available data series (appears to be through 2010), but projections through 2050 show annual increase in per capita VMT in BAU scenario. Same chart indicates per-capita and total VMT reductions will be reduced if VMT benchmarks are achieved in future years. Source: Kathy Leotta, WSDOT, VMT Targets, Strategies, and Challenges, May 5, 2010, American Association of State Highway and Transportation Officials (AASHTO), [Reducing GHG through VMT Strategies, Webinar, May 2010](#).

6.1 Pricing Strategy to Reduce VMT – MBUF and PAYD

Table 24: Potential Costs and Benefits and Additional Screening Criteria for Implementation of Pricing Strategies to Reduce VMT to Washington Consumers and Businesses

Potential Action for Consideration	
<ul style="list-style-type: none"> Implement a Mileage Based User Fee (MBUF) in place of the gasoline tax Require companies to provide a PAYD insurance offering 	
Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
<ul style="list-style-type: none"> All the co-benefits associated with VMT reduction, if effective Consumer cost savings are case-specific, and will depend on the amount of travel, among other factors Depending on pricing implementation, potential to disproportionately impact low income users; mitigation for impacts should be considered In general, there is high uncertainty on how these policies would actually affect GHG emissions; the results would largely be dependent on design and implementation, and if the approach provides enough signal, economic or otherwise, to incent behavior. 	<ul style="list-style-type: none"> Could create increased cost burden on businesses with high-VMT delivery and goods transport component, if insurance offerings changes
Summary of Screening Criteria	
<p><i>Does the policy target an emissions source of significant magnitude in Washington?</i> The transportation sector in the state of Washington accounted for 44 percent of total emissions in 2010. To the extent the policies effectively reduce VMT, it would reduce associated transportation emissions.</p> <p><i>What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?</i> Many states are investigating a MBUF as a revenue option to replace the insufficient gas tax. Data from MBUF program pilots have shown that VMT charges can be implemented to replace the gas tax as the principal revenue source for road funding,¹²⁷ but no studies of MBUF as a GHG policy have been reviewed.</p> <p>No comprehensive studies of PAYD program implementation have been identified.</p> <p><i>Is the policy discrete and comprehensive, or is it instead a bundle of related policies?</i> PAYD would be discrete and could be comprehensive of a subsector or transportation, depending on implementation. MBUF would be more comprehensive, depending on how it would be structured.</p> <p><i>Can the policy be meaningfully implemented or influenced at the State level?</i> For MBUF, yes, it would be implemented by the State.</p> <p>For PAYD, the state has a limited role. The Washington legislature already removed barriers to insurance</p>	

¹²⁷ Whitty, J. 2013. Page 45. Accessed July 2013 at:
http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf

companies' allowing PAYD. The State could consider requiring companies to offer it.

Pricing strategies to reduce VMT impose direct charges for the use of a roadway or roadways, with various goals. Goals may include revenue generation, as in the MBUF, or incentivizing behavioral changes such as driving less to reduce risk of accidents and associated costs to insurance companies, as in PAYD. The policies are defined as follows:

MBUF: implemented in the place of the gasoline tax, charges are assessed based on mileage traveled rather than fuel consumed, to directly tie charges to use of the system in order to account for highly fuel efficient vehicles, or vehicles that require no fuel.

PAYD insurance or Usage-Based insurance: the cost of insuring a motor vehicle is contingent on the type of vehicle, time, distance traveled, location, and behavior

MBUF and PAYD policies are grouped in this section even though they are very different in how they are implemented and to whom they apply. However as a GHG policy, both are targeting reduced VMT by putting a price on total vehicle trips per individual, family, or business, so the effectiveness of either is based on the elasticity of demand from this mechanism of cost. As such, a key policy design element for GHG reductions would be to maximize the information feedback to the driver on how much each mile costs. Once the VMT tax or PAYD insurance policy is implemented, drivers consider the cost of each mile, and adjust their driving patterns accordingly. As far as policy implementation, the policies are quite different, as one applies to private insurance companies, whereas the other applies to all drivers and is administered through an overseeing government entity or third-party government supported entity. Both of these two unique policy examples are grouped in this document because of their similarities in how they might affect GHG emissions, as discussed further below.

VMT charging policies charge drivers according to the number of miles traveled. Such policies may be implemented by the State government for revenue generation and/or congestion relief, with GHG reduction as a co-benefit.

Government road usage fees, MBUF: As cars increasingly become more fuel efficient, state and local governments receive less revenue from the traditional fossil fuel taxes to spend on road infrastructure maintenance and development. A MBUF can be used to generate revenue based on mileage traveled rather than fuel consumed, to account for highly fuel efficient vehicles, or vehicles that require no fuel. Under government VMT programs, a fee is assessed based on the number of vehicle miles that are traveled. Often, this fee replaces the gasoline tax to generate revenue for road infrastructure maintenance and development in response to increasing fuel efficiency in vehicles which is causing declining revenues. Under this system, users are paying for their actual use of the transportation system, rather than paying based on the quantity of fuel

that their vehicles consume. These programs can be as simple as a flat fee charged per mile based on odometer readings, or tiered fees based on distance, location, and other factors. Implementation can be done through various mechanisms, including pay-at-the-pump and onboard vehicle monitoring devices.

As part of the 2012 Supplemental Transportation Budget to the Washington State Transportation Commission (WSTC), the State of Washington provided funding to investigate the potential for VMT charges as an alternative to gasoline taxes and submitted a Work Plan and budget to the Legislature for further investigating the use of a VMT charge.¹²⁸ As part of the process, there was a series of four Steering Committee meetings from September 2012 to January 2013, ultimately finding that there were numerous viable implementation mechanisms for the use of a VMT-based charge in Washington. In developing the proposed Work Plan, a phased approach has been adopted to allow for evaluation of the project at various stages. Currently, the project is undergoing approval for Phase I, an estimated \$1.6 million in-depth research and development phase to refine the policy framework and operational concepts of the program.¹²⁹ Important policy issues raised for consideration during further investigation in Phase I of the project (if implemented) include:¹³⁰

- Relationship to the gas tax
- Social objectives (reduce energy, GHG, congestion or encourage transit)
- Rate setting and use of revenue
- Equity (income and urban/rural)
- Privacy
- Accounting for out-of-state motorists
- Accounting for out-of-state travel by residents

Washington's 2012 tax revenue from motor fuel sales tax was \$1.18 billion,¹³¹ and Washington's 2011 VMTs totaled 56.97 billion.¹³² Based on these values, an average VMT fee of approximately \$0.021 per mile, or \$210 per year for an individual driving an annual average of

¹²⁸ Washington State Transportation Commission. *Road Usage Charge Assessment*. Accessed July 2013
<http://www.wstc.wa.gov/StudiesSurveys/RUC2012/default.htm>

¹²⁹ Washington State Transportation Commission. Washington State Road Usage Charge Feasibility Assessment. Accessed September 2013 at:
http://waroadusagecharge.files.wordpress.com/2012/08/wastate_flyer_vfinal_screen2.pdf

¹³⁰ Transportation Committees of Washington State Senate and House of Representatives. Washington State Road Usage Charge Assessment. (PowerPoint Presentation). Slide 15. Accessed September 2013 at:
http://www.wstc.wa.gov/StudiesSurveys/RUC2012/documents/2013_02_RUCSummary.pdf

¹³¹ United States Census Bureau, American Fact Finder. Accessed September 2013 at:
<http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>

¹³² Washington State Department of Transportation. Measuring Delay and Congestion Annual Report: Congestion Report Dashboard of Indicators. Accessed September 2013 at:
http://wsdot.wa.gov/publications/fulltext/graynotebook/DB_CR12.pdf

10,000 miles, could generate enough revenue to replace the motor fuel sales tax. As previously stated, these policies are most often implemented as revenue generation mechanisms rather than GHG reduction policies. Implemented at this level, this cost is unlikely to influence driving behavior to substantially affect GHG emissions. On the other hand, some reports provide extremely optimistic results from the implementation of a MBUF. For example, the Rocky Mountain Institute estimates that there is a nationwide potential for between a 12 and 15 percent reduction in VMT with the implementation of a VMT tax, at a present value cost (in 2009 dollars) of \$168 billion for the entire country.¹³³

The Texas Transportation Institute offers archives of MBUF studies, symposium materials, and news through 2012.¹³⁴

Pay-As-You-Drive Insurance, or Usage-Based Insurance: Under PAYD insurance, the cost of insuring a motor vehicle is contingent on the type of vehicle, time, distance traveled, location, and behavior.^{135,136} Pay-as-you-drive insurance is currently offered in over 35 states, including Washington, in a variety of forms, through a variety of providers. “Low mileage discounts” are available in Washington State through several providers.¹³⁷

A 2008 Brookings study found that upon implementing nationwide pay-as-you-go insurance policies for all drivers, “[...] driving would decline by 8 percent nationwide, netting society the equivalent of about \$50 billion to \$60 billion a year by reducing driving-related harms. This driving reduction would reduce carbon dioxide emissions by 2 percent and oil consumption by about 4 percent. To put it in perspective, it would take a \$1-per-gallon increase in the gasoline tax to achieve the same reduction in driving.”¹³⁸

Beginning in 2012, pay-as-you-go became available in Oregon.¹³⁹ Progressive Universal Insurance Co. was the pilot company in Oregon¹⁴⁰, with seven companies now offering it in the

¹³³ Rocky Mountain Institute. *Summary of U.S. VMT Reduction Strategies*. (2011). Accessed July 2013 at: http://www.rmi.org/RFGGraph-Summary_of_US_VMT_reduction_strategies

¹³⁴ <http://utcm.tamu.edu/mbuf/>

¹³⁵ Orenstein, B. *Who's doing what? The rise of usage-based auto insurance*. Insure. (September 4, 2012). Accessed July 2013 at: <http://www.insure.com/car-insurance/usage-based-insurance-update.html>

¹³⁶ National Association of Insurance Commissioners and the Center for Insurance Policy and Research. *Usage-Based Insurance and Telematics*. (last updated May 29, 2013). Accessed July 2013 at: http://www.naic.org/cipr_topics/topic_usage_based_insurance.htm

¹³⁷ Pay-As-You-Go Insurance from Onstar/National General Insurance -- Low-Mileage Discount Offered in 35 States. Accessed July 2013 at: <http://www.lowmileagediscount.com/what-is-payg/lmd-states.asp>

¹³⁸ Bordoff, J. and P. Noel. *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*. The Brookings Institution. (July 2008). Accessed July 2013 at: <http://www.brookings.edu/research/papers/2008/07/payd-bordoffnoel>

¹³⁹ The Sightline Institute. *Pay-As-You-Drive Car Insurance*. Accessed July 2013 at: <http://www.sightline.org/research/payd/>

State.¹⁴¹ The policy is voluntary, and offers the benefit of reduced insurance cost to safe or infrequent drivers (up to a 45 percent reduction, depending on driving patterns), with the tradeoff of reduced privacy (mileage and location are tracked via a GPS-enabled device that also detects erratic braking and high speeds for some insurance companies).

In March 2012, with the passage of HB 2361 into law, there are no more known remaining legal barriers to PAYD insurance in Washington. The bill exempts certain information on usage-based insurers (including the usage-based component of the insurance rate) and users (including names and individual identification data of the insured) from public inspection during state filings. The bill also protects the insured from having data on their location collected by the insurance company without disclosure to and consent from the insured.¹⁴² A potential action the State may consider is to require companies to provide a PAYD insurance offering. An AASHTO webinar indicted estimates of GHG reduction potential in 2030 of 1.1 to 3.5 percent, ranging from whether states simply allow, or require companies to offer a PAYD option.¹⁴³

6.2 Investments in Public Transit Infrastructure

Table 25: Potential Costs and Benefits of Public Transit to Washington Consumers and Businesses

Potential Action for Consideration
<ul style="list-style-type: none"> Emphasizing an overarching goal of improving overall transportation system efficiency and reducing delay, establish an increased ridership goal, and fund proportionally - expanding service miles when ridership and demand exceeds current system capabilities. A doubling of ridership goal is reportedly unrealistic even assuming moderate increases in funding levels over most recent budget requests. It would more likely require a doubling of associated funding,¹⁴⁴ which would presume a major political and public opinion shift toward much greater subsidies to allow new capital investments and service, and lower fares to encourage maximum use. Through WSDOT, continue to provide and potentially increase: <ul style="list-style-type: none"> grants and technical assistance to aid local, and regional transit authorities planning assistance and direction on the types of projects in which investments should be made Communication and coordination with local and regional transit authorities to ensure that state-level goals and federal-level direction for transit development are implemented, providing a centralized view of the transportation system as a whole (including cross-jurisdictional travel between transit authorities, freeway travel, and other modes of travel)

¹⁴⁰ Oregon Environmental Council. *Pay-As-You-Drive Insurance*. Accessed July 2013 at:

<http://www.oeconline.org/our-work/climate-protection/transportation/other-transportation-solutions/payd>

¹⁴¹ Hunsberger, B. *Pay-as-you-drive car insurance: Trade your privacy for a price break?* The Oregonian. (March 2, 2013). Accessed July 2013 at: http://www.oregonlive.com/finance/index.ssf/2013/03/pay-as-you-go_car_insurance_tr.html

¹⁴² Engrossed Substitute House Bill 2361. <http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bills/House%20Passed%20Legislature/2361-S.PL.pdf>

¹⁴³ AASHTO, *Reducing GHG through VMT Strategies*, Webinar, May 2010.

¹⁴⁴ WSDOT Public Transportation Division staff, personal communication, September 18, 2013.

- Consider increasing the “local option” sales tax rate in cases where there is political will in order to allow local transit authorities to raise additional revenue
- Review the classification of public transit as it pertains to the 18th amendment to the Washington State Constitution, potentially allowing gas tax revenues to be used for transit purposes

Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
<ul style="list-style-type: none"> • Public transportation will never be self-supporting and will always require subsidies. In addition to Federal and State Government contributions of capital costs, funding for state-sponsored public transit improvements would likely come from an increase in taxes (fuel, motor vehicle excise) • Funding from local transit authorities would come from an increase in fares (ferries and transit) or local sales taxes • Benefits include improved mobility and accessibility for not only choice riders, but also captive riders that include elderly, poor, and disabled populations ; improved community and environment¹⁴⁵ • For consumers using public transit, reduced fuel consumption costs transportation expenditures (for example, some households may be able to reduce the total number of cars or save money on maintenance for vehicles used less frequently). 	<ul style="list-style-type: none"> • Increasing public transit service may reduce the need for businesses to offer parking for employees, and reduce developers’ parking requirements at new facilities • Funding for operating budgets for state-sponsored public transit improvements would likely come from an increase in taxes (e.g., fuel, motor vehicle excise)

Summary of Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?

Yes. The transportation sector in the state of Washington accounts for 44 percent of total emissions in Washington (in 2010). A policy that targets mode-shifting from low-occupancy vehicles to transit and increases public transit ridership as a component of a larger strategy to increase overall transportation system efficiency and reduce delay associated with congestion would reduce VMT and associated emissions from transportation fuel combustion.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

Fehr and Peers, for the State of Washington Department of Commerce in 2009 estimated that transit system enhancements and expansion could achieve two to ten percent reduction in mobile source GHG emissions, based on a doubling of transit revenue miles.¹⁴⁶ If a doubling of revenue miles is unrealistic given any foreseeable near- or medium-term scenario, then it can be deduced that the emission reduction

¹⁴⁵ Connecting Washington Task Force. January 6, 2012. Page 2.

¹⁴⁶ Fehr and Peers, prepared for the State of Washington Department of Commerce, Assessment of Greenhouse Gas Analysis Tools, 2009, accessed September 2013 at <http://www.commerce.wa.gov/Documents/GMS-Climate-Greehouse-Gas-Tool-Assess.pdf>

potential of lesser transit system enhancement and expansion policy than the ‘doubling’ assessed by Fehr and Peers would be relatively small compared to other transportation policy options.

In July of 2010, Johns Hopkins University and the Center for Climate Strategies estimated that transit expansion would result in 27.05 MMTCO₂e annual reduction in GHG emissions nationwide by 2020, at an expected \$16.72/mtCO₂e cost.¹⁴⁷ The analysis of expected reductions considered actions at the federal, state and local levels to implement transit programs, which included additional federal funding, additional state funding and “fast tracking” capital investment, and increased development of transit capacity and maintenance level of effort at the local level.¹⁴⁸

In 2008, the Washington State Climate Advisory Team quantified expected cumulative GHG savings of development and expansion of “Transit, Ridesharing, and Commuter Choice Programs” to be 23.6 MMTCO₂e for the State of Washington from 2008-2020 (cost was not quantified). This policy included reducing statewide per capita VMT and working with local governments and regional planning organizations to achieve state targets.¹⁴⁹

Of note, GHG reductions from expansion of public transit systems are achievable only when riders are taken off of the road at high enough levels to offset the GHG emissions from the operation of the transit system itself. Optimal reductions are achieved when systems are operating at or near ridership capacity. Therefore, it is important to increase ridership on existing infrastructure (which can be done by increasing frequency and reliability of service, among other alternatives) in addition to planning for system expansion.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

This policy is a bundle of related policies and guidance, and would govern an extensive network of 31 public transit authorities in the state.

Can the policy be meaningfully implemented or influenced at the State level?

Public transit is primarily a local activity in Washington, with the the 31 transit authorities in Washington function at the local or regional level. The state can take a variety of actions to support transit activities, which alone would not generate significant GHG emissions reductions:

- Providing grants and technical assistance to aid local, and regional transit authorities
- Providing planning assistance and direction on the types of projects in which investments should be made
- Communicating and coordinating with local and regional transit authorities to ensure that state-level goals and federal-level direction for transit development are implemented, providing a centralized view of the transportation system as a whole (including cross-jurisdictional travel between transit authorities, freeway travel, and other modes of travel)

The State has less influence over the following options that could allow for greater transit funding:

- Increasing the “local option” sales tax rate in cases where there is political will in order to allow local transit authorities to raise additional revenue

¹⁴⁷ Johns Hopkins University and Center for Climate Strategies. Impacts of Comprehensive Climate and Energy Policy Options on the U.S. Economy. July 2010. Table 2-2. Page 22.

¹⁴⁸ Johns Hopkins University and Center for Climate Strategies. July 2010. Table 4-1. Page 61.

¹⁴⁹ Washington Climate Advisory Team. Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State. January 25, 2008. Table 4.1. Page 76. Accessed September 2013 at: <https://fortress.wa.gov/ecy/publications/publications/0801008b.pdf>

- Reviewing the classification of public transit as it pertains to the 18th amendment to the Washington State Constitution, potentially allowing gas tax revenues to be used for transit purposes

Public transit serves purposes other than GHG reduction, including increased mobility of the population and accessibility to transportation, and reduced congestion. GHG reduction benefits from public transit come from moving a larger number of people on less fuel, and often cleaner fuel, than traditional passenger motor vehicle travel, reducing fossil fuel consumption, and therefore GHG emissions. In Washington as elsewhere, public transit is primarily a local activity serving the specific needs of each community. Within Washington, there are 31 transit authorities operating at the local or regional level, and the Washington State Department of Transportation's (WSDOT) role falls more to oversight and coordination with and among the transit authorities. As such, at the state level, Washington provides funding to aid local, and regional transit authorities, provide direction on the types of projects in which investments should be made, and communicate and coordinate with local and regional transit authorities to ensure that state-level goals for transit development are implemented. These types of activities while important will not generate significant gains in GHG reductions relative to the State's goals without a dramatic increase in funding levels.

The following section summarizes public transit investments in Washington. The WSDOT publishes an annual report summarizing the status of public transportation systems in the state. The most current report, updated in December 2012, summarizes the system's 2011 operations.¹⁵⁰ The State of Washington currently has 31 local public transit authorities, including 20 public transportation benefit areas (PTBAs), two unincorporated transportation benefit areas (UTBAs), five city and three county authorities, and one regional district authority.¹⁵¹ These transit systems had a total service area population of 5,847,118 people in 2011, covering 86 percent of the total state resident population.¹⁵² In 2011, the total operating investment in the state was \$1.9 billion, with 93 percent raised from local taxes, five percent from federal investment, and one percent from state support. The total capital investment in public transit in 2011 was \$353 million, with 90 percent from federal investment, six percent from local tax revenue, and four percent from state investment.¹⁵³ Public transit infrastructure in Washington State was given a "D+" (poor) grade by the Seattle Section of the American Society of Civil Engineers (ASCE) in their 2013 Report Card for Washington's Infrastructure, largely due to lack of maintenance, funding, and public transit options not keeping pace with population

¹⁵⁰ Washington State Department of Transportation. 2011 Summary of Public Transportation. Updated December 2012. Accessed August 2013 at:

<http://www.wsdot.wa.gov/publications/manuals/fulltext/m0000/TransitSummary/PTSummary.pdf>

¹⁵¹ Washington State Department of Transportation. Updated December 2012. Page 1.

¹⁵² Washington State Department of Transportation. Updated December 2012. Page 8 and page 14.

¹⁵³ Washington State Department of Transportation. Updated December 2012. Pages 11-12.

expansion.¹⁵⁴ While Washington has made investments in public transit and the State's grade is higher than the national average for transit (a "D"), this still indicates an area for improvement that would contribute to emission reductions, with the co-benefit of increased options for mobility and potentially quality-of-life for Washington residents.

Generally, the WSDOT and the State of Washington can affect public transit in the following ways:

- WSDOT:
 - Setting state-level goals for transit and communicating and coordinating with transit authorities to ensure implementation of goals (for example, WSDOT's mobility objective of expanding and improving the effectiveness of existing planning and grant programs that support intercity, rural and special needs transportation)¹⁵⁵
 - Providing grants and technical assistance to transit authorities
 - Providing planning assistance and direction on the types of projects in which investments should be made
 - Providing a centralized view of the transportation system as a whole (including cross-jurisdictional travel between transit authorities, freeway travel, and other modes of travel)
- State of Washington Legislative authority:
 - Approve "local option" sales tax rate that allows transit authorities to raise revenue
 - Review the classification of public transit as it pertains to the 18th amendment to the Washington State Constitution, potentially allowing gas tax revenues to be used for transit purposes

6.3 Literature Review of Washington Potential

Washington has released several reports in the past few years examining the role of the state in public transportation. In January 2011, the Washington State Legislature Joint Transportation Committee released a report on the State Role in Public Transportation, which was

¹⁵⁴ American Society of Civil Engineers (ASCE) Seattle Section. 2013 Report Card for Washington's Infrastructure. Page 65. Accessed July 2013 at: <http://www.seattleasce.org/reportcard/2013ReportCardWA.pdf>; and ACSE 2013 Report Card for America's Infrastructure State Facts: Washington. Accessed July 2013 at: <http://www.infrastructurereportcard.org/a/#p/state-facts/washington>

¹⁵⁵ Hammond, P. WSDOT Strategic Plan 2011-2017. Strategic Goal: Mobility (Congestion Relief). September 2010. Objective 3.9. Page 26. Accessed September 2013 at: <http://www.wsdot.wa.gov/NR/rdonlyres/533F8188-9F2B-4DAD-BF91-7590086A7904/0/StrategicPlan1117.pdf>

commissioned by the Washington State Legislature during the 2010 legislative session.¹⁵⁶ The report provided a general framework for state transportation efforts, and identified the following key areas for the state:

- Integrating transportation systems at the regional level
- Refining policies to encourage the use of public transportation
- Evaluating and refocusing funding sources and outlays in the immediate and long term
- Aligning reporting with federal systems
- Focusing on performance to meet basic mobility needs of constituents.

The key finding of the effort was that public transportation needs to be integrated into transportation planning as a whole.

In 2008, the Washington State Climate Advisory Team quantified expected cumulative GHG savings of development and expansion of “Transit, Ridesharing, and Commuter Choice Programs” to be 23.6 MMTCO₂e for the State of Washington from 2008-2020 (cost was not quantified). This policy, which includes a bundle of synergistic policies beyond just transit, included reducing statewide per capita VMT and working with local governments and regional planning organizations to achieve state targets.¹⁵⁷

In July 2011, Governor Christine Gregoire convened the 31 member Connecting Washington Task Force to develop a ten-year strategy for maintaining and improving Washington’s transportation system. The findings of the effort were summarized in a report released in January 2012, and broadly recommended that the state strategically invest \$21 billion in system preservation, strategic improvements, system efficiency and safety; portions of which would go to public transit investments (the amount allocated to public transit would be determined during design and implementation of the strategy).¹⁵⁸ The key theme of the Task Force’s work was that the investments in infrastructure should strengthen Washington’s economy and create in-state jobs.

¹⁵⁶ Washington State Legislature Joint Transportation Committee. Identifying the State Role in Public Transportation: Final Report. January 2011. Accessed August 2013 at: http://wstc.wa.gov/Meetings/AgendasMinutes/agendas/2011/January18/documents/011811_BP5_StateRolePublicTransportation.pdf

¹⁵⁷ Washington Climate Advisory Team. Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State. January 25, 2008. Table 4.1. Page 76. Accessed September 2013 at: <https://fortress.wa.gov/ecy/publications/publications/0801008b.pdf>

¹⁵⁸ Connecting Washington Task Force. Connecting Washington: Strategic Transportation Investments to Strengthen Washington’s Economy and Create Jobs. January 6, 2012. Accessed August 2013 at: http://www.wsdot.wa.gov/NR/rdonlyres/0DD6F466-6D52-4495-AAC6-78F2AA5B2332/0/ConnectingWashingtonfinal_report.pdf

Based on the Connecting Washington Task Force report, it is expected to cost \$2 billion over the next ten years to restore Washington's public transit system to pre-recession levels.¹⁵⁹ These are estimates of maintenance costs, and do not account for the cost of infrastructure improvements. The task force estimated that over \$50 billion dollars would be needed over the next ten years to maintain *and improve* existing infrastructure, which includes roads, bridges, freight mobility enhancements, ferry terminals, transit vehicles and increased transit services.¹⁶⁰ From that \$50 billion estimate, the task force recommended a ten year plan that includes \$21 billion of investment, to include \$2.5 billion for public transportation, \$1.3 billion in grants to cities and counties for improving mobility in key economic corridors, and \$11 billion for state-funded improvements to mobility in key economic corridors.¹⁶¹ The task force recommended that most of the funding for these expenditures be raised through tolling, taxes and fees on motor vehicles and through bond proceeds.

The Connecting Washington Task Force included members from various Washington State entities, including state senators and representatives, city council members, associations including Washington AAA, the Washington Transit Association, the Washington State Labor Council, and members representing various commercial interests. Despite the broad representation of interests on the Task Force, there was some response to the report and findings, notably from the Washington Policy Center. In May 2012, the Center released a policy brief which recommended that the state not create a state-level tax to fund local transit agencies, and that money raised through vehicle taxes (fuel, excise and other) only be used for highway maintenance and improvements, rather than for public transit improvements, citing the 18th amendment to the Washington State constitution. The foundation of the argument was that public transit is a local function with its own tax base and revenue generation, and that the state role should be limited to granting tax authority to local jurisdictions. The brief also argued that public transit is sufficiently funded in the state, and that taxes on drivers should go to much-needed infrastructure improvements.¹⁶²

¹⁵⁹ Connecting Washington Task Force. January 6, 2012. Page 13.

¹⁶⁰ Connecting Washington Task Force. January 6, 2012. Page 13.

¹⁶¹ Connecting Washington Task Force. January 6, 2012. Allocation of funding was not final, and was included for illustrative purposes. Pulled from Figure 8, Page 21.

¹⁶² Ennis, M. A Roadmap for Mobility: Recommendations on a Responsible Transportation Funding Plan for Washington State. Washington Policy Center, Center for Transportation. May 2012. Accessed August 2013 at: <http://www.washingtonpolicy.org/sites/default/files/A-Roadmap-For-Mobility.pdf>

7 Low Carbon Fuel Standard

Table 26: Potential Costs and Benefits of an LCFS Policy to Washington Consumers and Businesses

Potential Action for Consideration				
<ul style="list-style-type: none">Implement a Low Carbon Fuel Standard of a 10 percent reduction in the carbon intensity of the fuel mix over a 10 year time period in the State of Washington				
GHGs and Costs in Washington	GHG Reductions (MMTCO ₂ e)			Cost (\$/mtCO ₂ e) ¹⁶³
	2020	2035	2050	
10 % reduction in carbon intensity over 10 years	1.0	3.9	4.0	\$103 to \$131
Implementation Issues and Lessons Learned				
<ul style="list-style-type: none">There may be legal challenges to implementing an LCFS at state as opposed to federal level, as evidenced by the current litigation surrounding California’s LCFS.Sector exemptions should be carefully considered, such as those included in the California LCFS program. The California LCFS does not cover military activity, the racing industry, the aviation industry, marine fuels, or locomotive fuels.¹⁶⁴ Of important consideration to Washington will be the marine fuel exemption, which will affect the Washington State Ferries.				
Potential Costs and Benefits to WA Consumers		Potential Costs and Benefits to WA Businesses		
<ul style="list-style-type: none">Fuel prices for consumers may fluctuate, based on the cost of alternative fuels and feedstock, development of refining capacity for in-state biofuel production or purchase out-of-state alternative fuels, among other factorsEVs and AFVs are more expensive upfront than traditionally fueled base vehicles. These costs can be largely made up through Federal and state tax credits and over the term of ownership through lower fuel prices.¹⁶⁵		<ul style="list-style-type: none">Shifts away from petroleum-based fuels (gasoline and diesel) will have negative impacts on businesses involved in oil production, refining and transportation, along with ancillary business supporting those businessesSignificant increases in biofuel production will positively impact the farming and agricultural sectors of the economy, with additional demand for fuel feedstock. In addition, significant increases in biofuel production with positively impact companies involved in biofuel production, refining, and transportation. The impact to WA will depend on the proportion of the feedstock produced in-state.Shifts toward natural gas or electricity produced in-state will have positive impacts on businesses involved in those industries		
Summary of Screening Criteria				
<i>Does the policy target an emissions source of significant magnitude in Washington?</i>				
Yes. The transportation sector in the state of Washington accounts for 44 percent of total emissions in				

¹⁶³ 5 percent discount rate, NPV 2013

¹⁶⁴ California Air Resources Board (CARB). Final Regulation Order. Subchapter 10. Climate Change. Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions. Subarticle 7. Low Carbon Fuel Standard. Section 95480.1(d) Exemption for Specific Applications (Page 3).

<http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf>

¹⁶⁵ Mello, T. B. Ownership costs of traditional versus alternative fuel vehicles: Department of Energy calculator breaks down pricing. Autoweek. February 4, 2013. Accessed September 2013 at:

<http://www.autoweek.com/article/20130204/carnews/130209970>

Washington (in 2010). These emissions are the result of combustion of transportation fuels, so the implementation of a LCFS to reduce the carbon intensity of the fuel mix would have a corresponding effect on emissions from transportation fuel combustion.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

The costs and volume of reductions in other jurisdictions are discussed in further detail under Appendix A. Summary information for the California and Oregon LCFS is as follows:

- California: In advance of program implementation, ARB estimated total costs, including production, storage, transport and dispensing for various alternative fuels to range from \$1.4/GGE (cellulosic ethanol) to \$7.2/GGE (hydrogen).¹⁶⁶ California ARB estimates GHG reductions in 2020 of 15,800,000 from direct combustion of transportation fuels (in 2020) and 22,900,000 from the full fuel lifecycle (in 2020).¹⁶⁷
- Oregon: While costs were not estimated for the Oregon LCFS program, the volume of reductions from the program was expected to range from 2,189,000 to 2,285,000 (in 2022).¹⁶⁸ Note: The Oregon Department of Environmental Quality never moved to implement the standards because of the program's sunset date.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

An LCFS policy is discrete and comprehensive, covering a large source of emissions through a single policy mechanism. The policy examined in the Department of Ecology study was a 10 percent reduction in the carbon intensity of fuels from 2013 to 2023, which is a similar design to policies that were examined in other jurisdictions, including California, Oregon, British Columbia and the European Union.

Can the policy be meaningfully implemented or influenced at the State level?

There may be legal challenges to implementing an LCFS at state as opposed to federal level, as evidenced by the current litigation surrounding California's LCFS. Several court cases have challenged the California LCFS regarding the potential impact of the regulation on agricultural and ethanol production practices in other states. Plaintiffs assert that the regulation unfairly impacts out-of-state producers and therefore regulates conduct outside of California in violation of the Interstate Commerce Clause of the U.S. Constitution. On September 18, 2013, the 9th U.S. Circuit Court of Appeals ruled 2-1 that the California LCFS did not violate the Interstate Commerce Clause of the U.S. Constitution.¹⁶⁹ Challenges facing the California LCFS could be indicative of those that may face a proposed LCFS in Washington.

¹⁶⁶ Baral, A. International Council on Clean Transportation. *Summary Report on Low Carbon Fuel-Related Standards*. (October 2009). Page 11. Accessed July 2013 at:

http://www.theicct.org/sites/default/files/publications/ICCT_LCFS_workingpaper_Oct09.pdf (page 11)

¹⁶⁷ California Air Resources Board (CARB). *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume I: Staff Report: Initial Statement of Reasons*. (March 2009). Page VII-5. Accessed July 2013 at:

http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf

¹⁶⁸ Oregon Department of Environmental Quality. *HB 2186: Oregon Low Carbon Fuel Standards and Truck Efficiency*. (March 2013). Page 234. Accessed July 2013 at:

<http://www.deq.state.or.us/pubs/legislativepubs/2013/HB2186LegRpt2013.pdf>

¹⁶⁹ Jacobs, J. Appeals court rejects industry challenge to Calif. low-carbon fuel standard. E&E News PM. September 18, 2013. Accessed September 2013 at: <http://www.eenews.net/eenewspm/2013/09/18/stories/1059987472>

7.1 Introduction

The transportation sector in the state of Washington accounts for 44 percent of total emissions in Washington (in 2010), the result of combustion of transportation fuels. A low carbon fuel standard (LCFS) requires a reduction in the carbon intensity of the transportation fuel mix, on average, over time, considering the entire lifecycle of the fuels. The lifecycle of petroleum-based fuels includes the GHG emissions associated with crude recovery, crude transportation, fuel production, fuel transportation, and end-use of the fuel in motor vehicles. A parallel analysis would apply to non-petroleum motor fuels. The regulated entities tend to be fuel producers and importers who sell motor gasoline and diesel fuel. Today, the most common method for generating the credits required for compliance is the use of ethanol, followed by, to a lesser extent, natural gas and bio-based gases, biodiesel, and electricity.¹⁷⁰

At a national level, Congress has adopted a renewable fuels standard (RFS) under the Energy Independence and Security Act (EISA), which requires fuel providers to gradually increase the amount of biofuel in their products through 2022 (both cellulosic and biomass-based, though there are separate targets for each). The goals of an RFS and an LCFS are interrelated, but different, as are their structures. An RFS is explicitly targeted at increasing the supply of renewable fuels, and is generally prescriptive about the fuels that can be used for compliance. An LCFS on the other hand, provides a market mechanism that may be met through the use of renewable fuels, but is not prescriptive about which fuels must be used or to what extent. GHG reductions associated with improved fossil fuel production pathways are as equally legitimate in the context of an LCFS as GHG reductions associated with the use of renewable or alternative fuels. Currently, there is no national LCFS, and studies have returned conflicting results on the potential impacts of implementing such a policy. Further discussion of a federal LCFS policy is discussed in the Task 3 report on Federal policies. Several states have implemented LCFS, including Washington's western neighbors, California, Oregon and British Columbia.

While the costs and volume of reductions in other jurisdictions are discussed in further detail later in this document, it is worth noting that in California total costs, including production, storage, transport and dispensing for various alternative fuels range from \$1.4/GGE (cellulosic ethanol) to \$7.2/GGE (hydrogen),¹⁷¹ and California ARB estimates GHG reductions in 2020 of 15,800,000 mtCO₂e from direct combustion of transportation fuels (in 2020) and 22,900,000

¹⁷⁰ UC Davis Institute of Transportation Studies, *Status Review of California's Low Carbon Fuel Standard*, S.Yeh, J. Witcover, J. Kessler, Spring 2013, p. 1

¹⁷¹ Baral, A. International Council on Clean Transportation. *Summary Report on Low Carbon Fuel-Related Standards*. (October 2009). Page 11. Accessed July 2013 at:
http://www.theicct.org/sites/default/files/publications/ICCT_LCFS_workingpaper_Oct09.pdf (page 11)

mtCO₂e from the full fuel lifecycle (in 2020).¹⁷² Although no costs were estimated for the Oregon LCFS program, the volume of reductions from the program is expected to range from 2,189,000 mtCO₂e to 2,285,000 mtCO₂e (in 2022).¹⁷³

There may be legal challenges to implementing an LCFS at state as opposed to federal level, as evidenced by the current litigation surrounding California's LCFS. There has been a series of court challenges to the LCFS centered on the potential impact of the regulation on agricultural and ethanol production practices in other states. In December 2011, the U.S. District Court for the Eastern Division of California found that the regulation violated the Interstate Commerce Clause of the U.S. Constitution because it: 1) discriminates against the use of out-of-state corn-based ethanol; and 2) seeks to control farming and transportation practices outside of its own borders. In April 2012, the U.S. Ninth District Court of Appeals granted a stay of injunction while CARB appeals the injunction. The stay allows the program to be enforced until the appeal is resolved. On September 18, 2013, the 9th U.S. Circuit Court of Appeals ruled 2-1 that the California LCFS did not violate the Interstate Commerce Clause of the U.S. Constitution.¹⁷⁴ On June 6, 2013 California's Fifth Court of Appeals handed down a provisional ruling in a case that argued that the LCFS was implemented without adequate study of general environmental impacts as required by the California Environmental Quality Act (CEQA) and specifically improperly deferred development of mitigation measures for potential increases in NOx emissions that may occur due to the LCFS. The court has allowed CARB to proceed with the existing regulation but has provided formal direction for addressing the concerns raised by the lawsuit. Challenges facing the California LCFS could be indicative of those that may face a proposed LCFS in Washington.

Subsequent to the implementation of the California LCFS, there has been a series of dueling studies on the economic impacts of the regulation. The first, released in June 2012, was prepared by the Boston Consulting Group (BCG) on behalf of the Western States Petroleum Association (WSPA). Using proprietary models, the BCG forecast potentially dire economic consequences from the California LCFS including a loss of 28,000 to 51,000 jobs, a loss of \$4.4 billion in tax revenue and between \$0.33 and \$1.06 in costs per gallon.¹⁷⁵ A review of the BCG report by the UC Davis Policy Institute for Energy, Environment and the Economy identified seven critical

¹⁷² California Air Resources Board (CARB). *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume I: Staff Report: Initial Statement of Reasons*. (March 2009). Page VII-5. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf

¹⁷³ Oregon Department of Environmental Quality. *HB 2186: Oregon Low Carbon Fuel Standards and Truck Efficiency*. (March 2013). Page 234. Accessed July 2013 at: <http://www.deq.state.or.us/pubs/legislativepubs/2013/HB2186LegRpt2013.pdf>

¹⁷⁴ Jacobs, J. Appeals court rejects industry challenge to Calif. low-carbon fuel standard. E&E News PM. September 18, 2013. Accessed September 2013 at: <http://www.eenews.net/eenewspm/2013/09/18/stories/1059987472>

¹⁷⁵ Boston Consulting Group, *Understanding the Impacts of AB 32*, Prepared for the Western State Petroleum Association, June 19, 2012, pp.3-4. http://www.cafuelsfacts.com/wp-content/uploads/2012/07/BCG_report.pdf

assumptions and five intermediate conclusions that made significant contributions to the negative outcomes in the BCG study. These include no response in fuels demand to increased price, a limited availability of “bankable” compliance credits and a small number of advanced technology vehicles in the fleet by 2020.¹⁷⁶ In June 2013, ICF International released the first phase of a two-phase study of the California LCFS to be completed for the California Electric Transportation Coalition. The results of macroeconomic modeling will be contained in the yet-to-be-released second phase of the study, but the first phase sought to develop plausible compliance scenarios. Key findings that differ from the BCG assumptions include that there will be significant over-compliance and banking in the early years of the regulation, the LCFS is driving investment in low-carbon fuels, and natural gas consumption in the transportation sector is poised to expand rapidly.¹⁷⁷

A summary of existing LCFS policies and their relative successes is provided in Appendix A. Section 7.2 is a Literature Review summarizing existing work that has been done to evaluate the potential for, and impacts of, an LCFS in Washington. Section 7.3 presents original analysis conducted for this report, which evaluates the potential emission reductions and some of the associated costs and benefits of an LCFS in Washington in the target years 2020, 2035, and 2050.

7.2 Literature Review of Washington Potential

In May 2009, Washington State Governor Christine Gregoire issued an Executive Order (EO) directing the Washington State Department of Ecology to investigate the potential for a Low Carbon Fuel Standard in Washington in order to ... “assess whether the California low-carbon fuel standards; standards developed or proposed in other states, provinces or for the nation; or modified standards or alternative requirements to reduce carbon in transportation fuels would best meet Washington’s greenhouse gas emissions reduction targets.”¹⁷⁸ The Washington State Department of Ecology worked with the Departments of Commerce and Transportation and used consultant assistance to respond to the EO, assessing several scenarios for development and implementation of an LCFS in Washington.

For the analysis, the consultant, TIAX, constructed model runs around a hypothetical LCFS aimed at achieving a 10 percent reduction in fuel carbon intensity over a 10-year period. The

¹⁷⁶ University of California, Davis, *Expert Evaluation of the Report: Understanding the Impacts of AB 32*, May 2013, pp. 9-10, http://policyinstitute.ucdavis.edu/files/general/pdf/2013-05-09_Expert-Evaluation-of-BCG-Report.pdf

¹⁷⁷ ICF International, *California’s Low Carbon Fuel Standard: Compliance Outlook for 2020*, prepared for the California Electric Transportation Coalition, June 2013, pp.2-3., <http://www.caletc.com/wp-content/downloads/LCFSReportJune.pdf>

¹⁷⁸ Office of the Governor. Executive Order 09-05: Washington’s Leadership on Climate Change. May 21, 2009, Section (1)(f). Accessed August 2013 at: http://www.governor.wa.gov/office/execorders/eoarchive/eo_09-05.pdf

study assumed that the LCFS would have a 2013 start year, with 2023 being the target for achieving the desired fuel standard. The baseline carbon intensity, projected to 2013 based on 2007 data, was 92.2 gCO₂e/MJ, meaning that an LCFS of 10 percent reduction in carbon intensity would yield an 83 gCO₂e/MJ carbon intensity in 2026.¹⁷⁹

The TIAX study consisted of three main components. First, the study analyzed available in-state fuel supplies and found ample feedstock volumes for alternative fuel production in the state of Washington. Next, the study evaluated the carbon intensity of each fuel pathway, estimating a well-to-tank (WTT), a tank-to-wheel (TTW) and a well-to-wheel (WTW) emission reduction for the various scenarios being examined.¹⁸⁰ Emissions from indirect land use change (ILUC) were also examined.

Finally, the consultant constructed six compliance scenarios to capture the range of possibilities and performed economic analyses on the various scenarios. The compliance scenarios, intended to gauge the impacts of various pathways to achieving the desired LCFS treated gasoline and diesel “pools” separately in all but one scenario. The scenarios are summarized below:

- Scenario A: Compliance through cellulosic ethanol and diesel fuels produced in-state
- Scenario B: Compliance through cellulosic ethanol and diesel fuels produced out-of-state
- Scenario C: Compliance through mixed sources of biofuels: conventional, cellulosic, imported and in-state.
- Scenario D: Compliance through high electric vehicle (EV) sales and in-state cellulosic biofuels.
- Scenario E: Compliance through high electric vehicle (EV) sales and mixed sources of biofuels.
- Scenario F: One-Pool: a “middle-of-the-road” scenario combining a mixture of biofuel and electrical vehicles, and increased use of light duty diesels

Following the completion of the TIAX study, one of the primary authors, Jennifer Pont, prepared an analysis of the impact of updated assumptions on the non-economic conclusions of the TIAX study. The report, released by Life Cycle Associates, LLC (LCA) identified several key assumptions upon which the TIAX study was based, and which Pont/LCA found should be

¹⁷⁹ Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011. Page 3. Accessed August 2013 at: http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf

¹⁸⁰ Well-to-wheel (WTW) emissions are the fuel lifecycle emissions, which can be broken into two parts: well-to-tank (WTT), which refers to fuel production and tank-to-wheel (TTW), which refers to vehicle tailpipe emissions.

updated. While several key assumptions should be updated, Pont/LCA note that the impact on the non-economic conclusions of the original study are likely minimal.¹⁸¹

The TIAX study estimated both a tank-to-wheel (TTW) and a well-to-wheel (WTW) emission reduction for the various scenarios being examined. The TTW estimated emission reduction from the policy ranged from 1.5 MMTCO₂e to 3.5 MMTCO₂e, while the WTW estimated emission reduction from the policy ranged from 1.5 MMTCO₂e to 4 MMTCO₂e. The range in emissions is attributable to the variety of fuels and technologies applied in each scenario.¹⁸² These estimates were generated using the carbon intensity values generated by the consultant for the various fuel pathways. Carbon intensity measures the amount of CO₂e per unit output, in this case, grams of CO₂e per MJ. The results of the carbon intensity evaluation that fed this analysis are summarized in Table 27, below.

Table 27: Summary of Estimated Carbon Intensity Values for Fuel Pathways Considered
[Reproduced from Pont, J. and J. Rosenfeld (TIAX)]

Carbon Intensity (g CO ₂ e/MJ)	WTT			TTW				ILUC	WTW
	Feedstock & Transport	Production & Transport	WTT Total	Vehicle CO ₂	Vehicle CH ₄	Vehicle N ₂ O	TTW Total		
Gasoline Blendstock	7	11	18	73	0.1	1.4	74	0	92
Gasoline (10% Corn Ethanol)	8	13	21	68	0	1.4	69	2	92
Ultra Low S Diesel	7	10	16	75	0.02	0.05	75	0	91
Ethanol, MW Corn Average	21	44	65	0	0.25	0.58	0.83	28	94
Ethanol, NW Prod., MW Corn	22	35	57	0	0	0.6	1	28	86
Ethanol, Farmed Trees	12	-2	10	0	0	1	1	4	15
Ethanol, Wheat Straw	15	2	17	0	0	1	1	0	18
Ethanol, Forest Residue	11	8	19	0	0	1	1	0	20
Ethanol, Mill Waste	4	8	11	0	0	1	1	0	12
Ethanol, Brazil Sugarcane	20	0	20	0	0	1	1	26	46
Biodiesel, MW Soybeans	6	11	17	3.04	0.01	0.65	4	47	68
Biodiesel, NW Canola	15	7	23	3	0	1	4	0	26

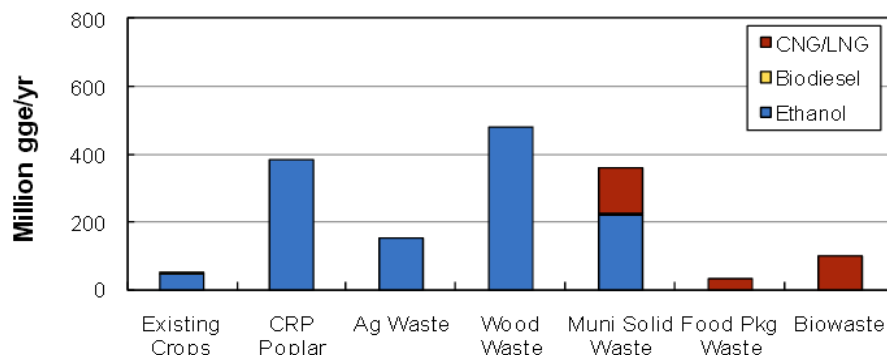
¹⁸¹ Pont, J. Life Cycle Associates, LLC. WA LCFS Analysis: Implication of Updated Assumptions. July 3, 2013. LCA.8047.84.2013.

¹⁸² Pont, J. and J. Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Pages 85-86

Carbon Intensity (g CO ₂ e/MJ)	WTT			TTW				ILUC	WTW
	Feedstock & Transport	Production & Transport	WTT Total	Vehicle CO ₂	Vehicle CH ₄	Vehicle N ₂ O	TTW Total		
Biodiesel, Yellow Grease Average	3	6	9	3	0	1	4	0	13
Biodiesel, Tallow Average	17	6	23	3	0	1	4	0	27
RD II, NW Prod., MW Soy Oil	6	14	19	0	0	1	1	47	67
Electricity, WA Grid Mix + RPS	1	21	23	0	0	0	0	0	23
CNG, pipeline NG	8	2	10	56	0	2	59	0	69

In addition to calculating the carbon intensity of fuels, TIAX concluded that there were ample feedstock volumes for alternative fuel production in the state of Washington. The feedstocks considered ranged from cultivated feedstocks (starches, cellulose, oils) to utility-based feedstocks (natural gas and renewable electricity) to waste derived feedstocks (agricultural, wood and food packaging waste, MSW and biowaste).¹⁸³ In total, the study estimated that alternative fuels produced from these feedstocks have the potential to displace up to 40 percent of Washington's 2007 petroleum consumption.¹⁸⁴ Figure 5, pulled from the TIAX report, summarizes the types and quantities of alternative fuel production potential in the state.

Figure 5: Summary of Types and Quantities of Alternative Fuel Production Potential in Washington [Figure from Pont, J. and J. Rosenfeld (TIAX)]



¹⁸³ Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011. Page 3. Accessed August 2013 at: http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf

¹⁸⁴ Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Page 7.

While feedstock volumes are available, TIAX identified processing infrastructure as a potential limiting factor. They note that there is a lack of commercial-scale cellulosic ethanol production capacity in Washington, despite existing State policy and incentives¹⁸⁵ and considerable cellulosic ethanol feedstock available in-state (this impacts Scenarios A, C, D, E and F of the analyses run in the study). There are no commercial-scale cellulosic ethanol production plants planned in the state of Washington, though there are two pilot projects in Oregon: Pacific Ethanol and ZeaChem, that may provide a means for expansion of production into Washington if they prove successful. In contrast to cellulosic ethanol production, the study notes significant conventional biodiesel production capacity in the state, with over 130 million gallons per year of capacity among four firms.¹⁸⁶

The 2011 economic modeling considered a variety of impact categories, including fuel consumption and expenditures, vehicle expenditures and infrastructure costs, and found that there would be a range of impacts on the Washington State economy as a result of the implementation of the LCFS. Overall, the study found that the economic impacts would be a primarily positive as the result of the LCFS in all scenarios, with the exception of Scenario B (compliance through cellulosic ethanol and diesel fuels produced out-of-state), which was the only scenario to have negative results in employment, personal income, and gross state product. While all impacts were relatively small (less than 0.5 percent), scenarios that saw net growth were positive due to increases in economic activity within the state, as increased in-state investments have direct impacts on expenditures on intermediate goods. Scenario B saw net negative impacts due to the sourcing of cellulosic ethanol from out-of-state, which means that investments were not on in-state sources, and therefore did not have the positive impact on the Washington state economy. The primary findings are as follows:¹⁸⁷

Employment	Depending on the scenario, employment relative to the BAU case was expected to be impacted by a range of negative 0.01 percent to positive 0.32 percent on average per year. This range represents a change in employment in Washington as a result of the policy between a net loss of 200 jobs to a gain of 12,000 jobs on average per year in the Washington State economy between 2014 and 2023.
Personal Income	Depending on the scenario, total personal income relative to the BAU case was expected to range from a decline of 0.01 percent to an increase of 0.20

¹⁸⁵ Existing state policies and incentives include loans, grants, tax exemptions and deductions. A list of current initiatives is available through EERE AFDC here: <http://www.afdc.energy.gov/laws/laws/WA/tech/3252>

¹⁸⁶ Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Page 8.

¹⁸⁷ Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Table 8-2. Page 121.

percent on average per year. This range would mean between a total net loss of \$13.8 million dollars to a total net gain of \$526.4 million dollars of personal income on average per year for Washington State residents between 2014 and 2023 (US\$ 2008).

Gross State Product Depending on the scenario, effects on gross state product ranged from an expected decrease of 0.01 percent to an increase of 0.29 percent on average per year.¹⁸⁸ This range represents a change in gross state product as a result of the policy between a total net loss of \$36.5 million to a total net gain of 741.3 million (US \$2000) on average per year.

These findings show that potential for in-state economic growth is highly dependent on the pathway to compliance with the LCFS. Using the scenarios modeled in the TIAX study as an example, there may be net positive impacts on job growth, personal income and gross state product if aggressive in-state production and refining of biofuels are pursued to achieve the desired LCFS (as in Scenarios A, C, D, E and F, to varying extents). Alternatively, if out-of-state biofuels are purchased and imported to achieve the LCFS (as in Scenario B), this would have a net negative impact on jobs, personal income and gross state product.

Further, the implementation of an LCFS policy in Washington State may require significant investments in alternative fuel capacity in the state, including additional refining capacity for ethanol and biodiesel, labor, utilities and feedstock for new refinery operations, infrastructure investments for natural gas and biodiesel distribution, and additional vehicle costs for natural gas-powered heavy duty vehicles.¹⁸⁹ The economic impact numbers of each of the modeled scenarios in the TIAX study are summarized in Table 28.

Table 28: The Washington LCFS Scenarios Average Annual Economic Impact 2014-2023
[Reproduced from Pont, J. and J. Rosenfeld (TIAX)]

Reference Case	Employment (1,000s)	Total Personal Income (\$2008, Millions)	Gross State Product (\$2000, Millions)
Scenario A	12	526.4	741.3
Scenario B	(0.2)	(13.8)	(36.5)
Scenario C	3.9	177.7	225.3
Scenario D	8.2	341.7	454.2
Scenario E	3.6	147.6	164.4

¹⁸⁸ Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Table E-3. Page ix, Table E-3.

¹⁸⁹ Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Page 119.

Scenario F	6	281.6	389.3
Business-as-Usual, 2009 Level	3,727.4	263,524.4	259,603.0

7.3 Quantification

This section builds on previous analysis, including the consultant work performed in by TIAX for the Department of Ecology in 2011, which estimated the carbon intensity of various fuel pathways. This section analyzes the potential GHG emission reductions that could be generated from implementation of a low carbon fuel standard in Washington. This analysis is much more limited in scope than the work previously conducted for the State, and is intended to provide an analysis consistent with the others produced for this effort, to be used for high-level policy evaluation. Importantly, this analysis projects beyond the initial LCFS compliance period to 2035 and 2050, to provide a picture of the long-term outcomes that could be expected from an LCFS policy. In particular, this analysis considers how an LCFS might result in increased demand of alternative fuels and decreased demand for traditional gasoline and diesel fuel, and associated fuel expenditures.

The LCFS policy examined in this section assumes a start year of 2016, and a 10 percent reduction in the GHG carbon intensity of the fuel mix by the year 2025, consistent with LCFS implemented in other states and modeled by TIAX in 2011 (start date adjusted to reflect evaluation in 2013). This analysis further stipulates, however, that the LCFS policy is maintained at a 10 percent reduction in 2035 and 2050.

7.3.1 Methodology

To quantify the emission reductions from an LCFS in Washington, a compliance pathway was constructed which increases the reduction in GHG intensity from zero to 10 percent over the course of a 10-year period ending in 2025, then increasing more gradually to 20 percent in 2035 and 30 percent in 2050. The compliance schedule to 10 percent was derived from the work completed for the Department of Ecology in 2011, which defined percentage reductions for each year. The schedule was shifted to a 2025 attainment date to reflect a potential start date of 2016. In addition to a compliance schedule for achieving carbon intensity reductions, the analysis also applies the baseline carbon intensity of the Washington fuel mix from the 2011 consultant report. The compliance schedule is shown in Table 29.

Table 29: Compliance schedule modeled in hypothetical LCFS policy calculations. Intermediate years 2026-2034 and 2036 to 2049 not shown.

Year	Percentage Reduction	LCFS Carbon Intensity (gCO ₂ e/MJ)
2015	Baseline (0.0%)	92.20

2016	0.25%	91.97
2017	0.50%	91.74
2018	1.00%	91.28
2019	1.50%	90.82
2020	2.50%	89.90
2021	3.50%	88.97
2022	5.00%	87.59
2023	6.50%	86.21
2024	8.00%	84.82
2025	10.00%	82.98
2035	10.00%	82.98
2050	10.00%	82.98

GHG emission reductions from the LCFS were calculated based on gasoline and diesel fuel consumption projections in Washington State by the Office of Financial Management (OFM) Transportation Revenue Forecast Council.¹⁹⁰ Projections were provided to 2040, and the 2050 projection used in this analysis was calculated based on the linear trend to 2040. Gasoline and diesel pools were treated separately in the analysis, consistent with prior consultant work. However, in reality, the LCFS would not necessarily require equal reductions from gasoline and diesel, and instead can be constructed to enable trading of credits and reductions across fuels and suppliers, which would likely reduce overall costs.

In addition to GHG reductions resulting from an LCFS, several compliance scenarios were constructed to illustrate a range of shifts in fuel use. These scenarios are intended to demonstrate that an LCFS does not dictate the precise replacement fuels, and that the volumes of fuels and associated costs are highly dependent on the ways in which the market responds, technologies mature, and on consumer preference. As noted, gasoline and diesel pools were modeled separately. Rather than attempt to project specific fuels that will be available and dominant in the future, this analysis defines several biofuel pathways representing various carbon intensities. Although there is significant uncertainty regarding the specific fuel pathways that will be available in the future, these carbon intensities were selected in order to reflect an expected decrease in carbon intensity of biofuels through time due to technological and market advances. The percentages presented in the tables below represent the percent of the non-gasoline or non-diesel fuel mix that will be met by each fuel.¹⁹¹ Table 30 summarizes the two gasoline scenarios, one of which assumes that electricity will fill only 25 percent of the gasoline replacement market by 2050, and the other assuming that electricity reaches 50 percent.

¹⁹⁰ OFM Transportation Revenue Forecast Council, Washington State Motor Vehicle Fuel Tax Extended Forecast, June 2013

¹⁹¹ This methodology and the assumptions were developed with assistance from Washington Department of Ecology and Washington Department of Commerce.

Table 30: Compliance scenarios modeled for the gasoline pool. Percentages represent the portion of decreased gasoline consumption that is met by each fuel

Fuel	Lifecycle Carbon Intensity (gCO ₂ e/MJ)	Percent of Gasoline Replacement (Low Electric Vehicle Scenario)			Percent of Gasoline Replacement (High Electric Vehicle Scenario)		
		2020	2035	2050	2020	2035	2050
Ultra Low Carbon Ethanol	15	5%	10%	15%	5%	15%	15%
Low Carbon Ethanol	20	0%	5%	10%	0%	10%	15%
Moderate Carbon Ethanol	46	15%	15%	15%	15%	10%	5%
High Carbon Ethanol	86	5%	5%	5%	5%	5%	5%
Ultra High Carbon Ethanol	94	70%	50%	30%	70%	35%	10%
Electricity	23*	5%	15%	25%	5%	25%	50%

*Reflects an EER of 3.0

Table 31 summarizes the two diesel scenarios modeled, one of which assumes that compressed natural gas (CNG) will fill only 15 percent of the diesel replacement market, and the other assuming that CNG reaches 50 percent. These scenarios were used to calculate the potential changes in volumes and fuel costs resulting from an LCFS.

Table 31: Compliance scenarios modeled for the diesel pool. Percentages represent the portion of decreased diesel consumption that is met by each fuel

Fuel	Lifecycle Carbon Intensity (gCO ₂ e/MJ)	Percent of Diesel Replacement (Low CNG Vehicle Scenario)			Percent of Diesel Replacement (High CNG Vehicle Scenario)		
		2020	2035	2050	2020	2035	2050
Ultra Low Carbon Biodiesel	4	5%	10%	15%	5%	10%	10%
Low Carbon Biodiesel	13	25%	30%	30%	25%	25%	25%
Moderate Carbon Biodiesel	26	25%	25%	25%	25%	20%	15%
High Carbon Biodiesel	68	40%	25%	15%	40%	20%	0%
Pipeline CNG	77*	5%	10%	15%	5%	25%	50%

*Reflects an EER of 0.9

The gasoline and diesel replacement percentages in Table 30 and Table 31 above were used to calculate a weighted carbon intensity of the replacement fuel mix. Based on this weighted carbon intensity, the amount of gasoline and diesel that would need to be replaced to meet the LCFS carbon intensity was calculated. Because of different energy densities and energy economy ratios (EER), the quantity of replacement fuel is not simply equal to the reduction in gasoline and diesel. Therefore, the appropriate EER and energy densities were applied to calculate how many

units of each alternative fuel would be required based on the percentage of diesel or gasoline energy replaced by each source.

To demonstrate how an LCFS would result in a shift of fuel expenditures, base price forecasts were used to estimate the change in cost associated with each fuel type in the target years. In analyzing the costs and benefits of its LCFS policy, California ARB assumed that future fossil fuel costs would be unchanged. However, a study by Boston Consulting Group estimated that implementation of California LCFS would result in increased costs to industry requiring cost recovery of \$0.33 to \$1.06 per gallon.¹⁹² A subsequent analysis by the UC Davis Policy Institute, however, concluded that the BCG report was too narrow in scope (looked solely at the refining sector), and included a variety of problematic assumptions.¹⁹³ Additionally, BCG's cost estimates reflect a compliance pathway where fossil fuel providers are forced to purchase LCFS credits from producers of low carbon fuels. As such, these costs represent a wealth transfer within the economy, and not a net cost to the State. Based on this characterization of industry costs as a transfer, and the fact that any increase in fossil fuel cost would correspond to a decrease in costs to alternative fuel providers, the price of fuel is assumed not to change as the result of LCFS.

However, total expenditures on fuel will change as a result of changes in consumption patterns. These changes are calculated in order to demonstrate shifts in spending among fuels – some of which may be generated in-state – but are not intended to represent overall economic impact. For example, although total fuel costs may increase, some of that spending may be more likely to stay in state if biofuel refining capacity is increased, partially or entirely offsetting the change. Alternatively, increased spending on electricity or CNG relative to gasoline will have differential impacts on those sectors of the economy.

The incremental cost of new vehicles was calculated using incremental cost data for the gasoline pool from the Department of Energy's VISION model produced by Argonne National Laboratory. Volumes of biodiesel and ethanol in all projected scenarios were low enough that it was assumed these fuels could be accommodated without any significant change to fleet dynamics. However, for electricity in the gasoline pool and CNG in the diesel pool, additional vehicles will be required to utilize these fuels. Data for vehicle miles traveled (VMT) for each vehicle type as well as fuel economy of each vehicle type were extracted from VISION in order to calculate the number of additional medium-duty CNG and electric vehicles required. The costs

¹⁹² Boston Consulting Group. 2012. Understanding the impact of AB 32. Accessed September 2013 at: http://cafuelfacts.com/wp-content/uploads/2012/07/BCG_report.pdf

¹⁹³ UC Davis Policy Institute for Energy, Environment and the Economy. 2013. Expert Evaluation of the Report: "Understanding the Impacts of AB32". Accessed September 2013 at: http://policyinstitute.ucdavis.edu/files/general/pdf/2013-05-09_Expert-Evaluation-of-BCG-Report.pdf
May 2013

associated with these additional vehicles were calculated as the incremental cost relative to the baseline technology. For electric vehicles, this value was extracted for the appropriate year for VISION. Because comparable cost data are not available for medium-duty CNG vehicles, this analysis relies on the incremental cost for medium-duty CNG vehicles estimated in the 2011 TIAX consultant report.

Lastly, the potential distributional impact of LCFS on the oil industry and alternative fuels industry is estimated based on previous work by BCG. The per gallon increase in cost to the oil industry calculated by BCG is multiplied by the total volume of gasoline and diesel consumed in Washington in the analyzed scenarios.

7.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions about the structure of the LCFS policy, the path toward attainment, associated data parameters, and exclusions are included in this analysis:

- The LCFS begins in 2016
- The baseline carbon intensity of the fuel mix is 92.2 gCO₂e/MJ for all fuels combined.
- The carbon intensity compliance requirements are applied separately to gasoline and diesel fuel pools
- The target carbon intensity of a 10 percent reduction is met in 2025, 2035, and 2050. The carbon intensity in 2020 represents a 2.5 percent reduction, on the path to the 2025 goal.
- Energy (MJ) consumed by the transportation sector is unaffected by the LCFS; however quantities of fuels are affected
- Fuel prices are not affected by the LCFS. Although there may be some shifts in prices due to trading in LCFS credits, these represent transfers within the economy. Additional costs to fossil fuel consumers would correspond to decreased costs to alternative fuel consumers.
- Biodiesel is 19 percent more expensive in the forecast years than diesel, consistent with Washington State Department of Transportation¹⁹⁴
- There is a general trend towards lower carbon biofuels, and away from higher carbon biofuels due to anticipated technology improvement and market maturity.
- The business-as-usual fleet is able to accommodate the volumes of ethanol and biodiesel projected. However, additional medium-duty CNG trucks and electric vehicles are required to utilize the increased volumes of CNG and electricity resulting from the LCFS.
- Costs quantified include changes in fuel costs and technology costs. Additionally, decreases in fuel tax collections are quantified as an economic transfer.

¹⁹⁴ Washington State Department of Transportation. 2013. Annual Fuel Price Forecast

This analysis relies on the data sources summarized in Table 32.

Table 32: Primary data sources used to quantify GHG impacts of a Washington State LCFS

Data	Source
Gasoline and diesel consumption forecasts	OFM Transportation Revenue Forecast Council, Washington State Motor Vehicle Fuel Tax Extended Forecast, June 2013
Price of diesel and price differential to biodiesel	Washington State Department of Transportation. 2013. Annual Fuel Price Forecast
Price of gasoline, ethanol, natural gas, and electricity	EIA, Annual Energy Outlook 2013. Table 3.9. Energy Prices by Sector and Source – Pacific.
Carbon intensities, EERs, and energy densities of the fuels	Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011
Fuels and fuel ratios replacing gasoline and diesel	Personal communication: Washington Department of Ecology, Washington Department of Commerce
Incremental Cost of alternative fuel vehicles	DOE, VISION model; Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011

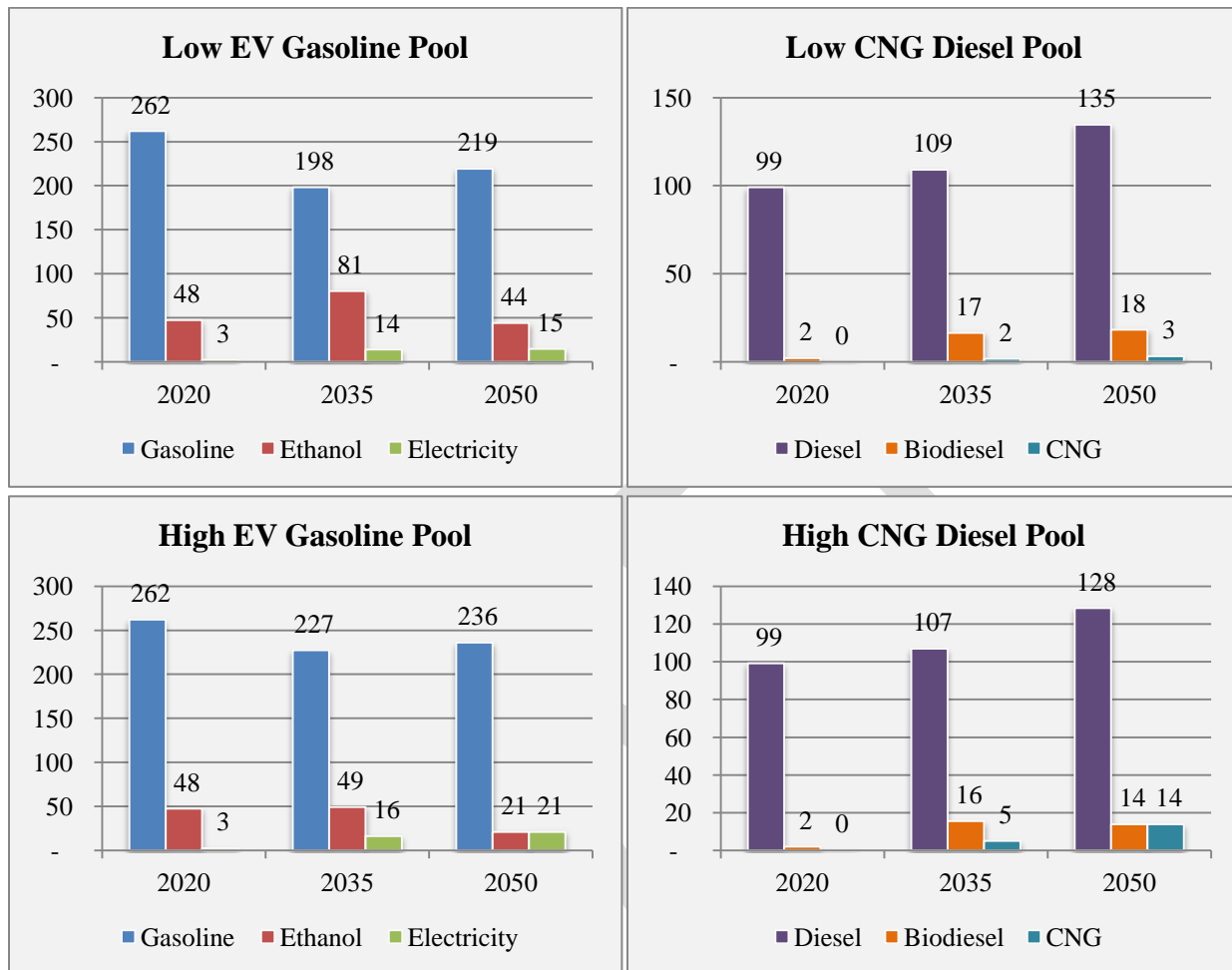
7.3.3 Results

Based on an LCFS that achieves a decreased carbon intensity of 10 percent by 2025, and maintains that level through 2050, estimated GHG emission reductions are 1.0 MMTCO₂e, 3.9 MMTCO₂e, and 4.0 MMTCO₂e annually in 2020, 2035, and 2050, respectively. Table 33 summarizes the baseline emissions forecast for gasoline and diesel pools, as well as the emissions forecast for these pools under the assumed LCFS. Emissions in the LCFS scenario include emissions from alternative fuels in addition to the base fossil fuels.

Table 33: GHG reductions from a Washington State LCFS

	2020 (MMTCO ₂ e)	2035 (MMTCO ₂ e)	2050 (MMTCO ₂ e)
LCFS Target	2.5 percent	10 percent	10 percent
Baseline Emissions	38.1	38.8	40.1
Gasoline Pool	28.8	27.0	25.7
Diesel Pool	9.4	11.8	14.4
Emissions Under LCFS	37.2	34.9	36.1
Gasoline Pool	28.1	24.3	23.1
Diesel Pool	9.1	10.6	13.0
Emission Reductions	1.0	3.9	4.0
Gasoline Pool	0.7	2.7	2.6
Diesel Pool	0.2	1.2	1.4

In addition to the GHG reductions, calculations were performed to examine different scenarios by which the LCFS might be met. These scenarios, constructed with input from State officials, model different levels of penetration for CNG vehicles into the diesel market, and EVs into the gasoline market. The remainder of the carbon reductions are met through the mixes of ethanol and biodiesel described in Table 30 and Table 31, above. Figure 6 illustrates how the different fuels in the gasoline and diesel pools enter the Washington market. Each figure shows the MJ of diesel or gasoline that is replaced with alternative fuels in order to meet the LCFS. Ultimately, more or less MJ of the alternative fuel may be required to meet the decreased gasoline or diesel fuel due to the EERs. For example, with an EER of 3.0, only one MJ of delivered electricity is required to meet the demand previously satisfied by 3 MJ of gasoline. What is noteworthy about Figure 6 is that the impact on traditional fuels of meeting the LCFS is highly dependent on the alternative fuels available. In the low CNG vehicle scenario, diesel consumption decreases by 21 billion MJ (160 million gallons) in 2050. However, because CNG has a higher carbon intensity than the modeled biodiesel fuels, a scenario in which CNG plays a larger role requires greater reductions in diesel fuel. In the high CNG vehicle scenario, a reduction of 28 billion MJ (206 million gallons) of diesel is required to meet the 10 percent LCFS in 2050.

Figure 6: Fuel use under an LCFS in gasoline (left) and diesel (right) scenarios. (Billion MJ)¹⁹⁵

Based on these scenarios, estimated changes in energy expenditures by source are shown in Table 34, along with the incremental vehicle spending for CNG and electric vehicles to accommodate these fuels. All biodiesel pathways have been aggregated, as have all ethanol pathways for simplicity of presentation. All scenarios result in a net increase in total costs, primarily due to the higher projected price of ethanol and biodiesel on an energy basis relative to gasoline and diesel.¹⁹⁶ Current prices for these biofuels are at parity or lower than their fossil fuel counterparts on a volumetric basis, but due to their lower energy content they track closely with, or cost somewhat more than gasoline and diesel, which is reflected in price forecasts used for

¹⁹⁵ All MJ values are presented as the MJ required for gasoline or diesel (depending on pool). Actual MJ delivered to meet the LCFS may vary. For example, with an EER of 3.0, electricity will only actually supply one third of the MJ presented for the gasoline scenarios.

¹⁹⁶ Through 2035, ethanol is projected to be less expensive than gasoline per gallon. However, due to its lower energy content and the requirement to meet the energy demand of the replaced gasoline, ethanol is more expensive on an energy basis.

this analysis. As a result, the cost-effectiveness of the LCFS from potential inception in 2016 through 2035 is \$103 to \$131 per mtCO₂e reduced.

Table 34: Changes in fuel consumption and expenditures for scenarios in the gasoline pool. Positive values represent increased costs, and negative values represent cost savings

(million \$US)	2020	2035	NPV 2016-2035 ^a
Low CNG Scenario	\$16	\$135	\$505.1
Diesel (million \$US)	\$(61)	\$(624)	\$(2,230)
Biodiesel (million \$US)	\$73	\$712	\$2,577
CNG (million \$US)	\$2	\$38	\$120
Vehicles (million \$US)	\$2	\$9	\$38
High CNG Scenario	\$16	\$99	\$402.8
Diesel (million \$US)	\$(61)	\$(701)	\$(2,448)
Biodiesel (million \$US)	\$73	\$667	\$2,452
CNG (million \$US)	\$2	106	\$310
Vehicles (million \$US)	\$2	\$9	\$88
Low EV Scenario	\$406	\$566	\$4,821
Gasoline (million \$US)	\$(1,423)	\$(3,194)	\$(20,281)
Ethanol (million \$US)	\$1,777	\$3,567	\$24,144
Electricity (million \$US)	\$28	\$159	\$671
Vehicles (million \$US)	\$24	\$33	\$41
High EV Scenario	\$406	191	\$3,771.0
Gasoline (million \$US)	\$(1,423)	\$(2,213)	\$(17,532)
Ethanol (million \$US)	\$1,777	\$2,181	\$20,260
Electricity (million \$US)	\$28	\$184	\$740
Vehicles (million \$US)	\$24	\$39	\$287
GHG Reductions (MMTCO₂e)	1.0	3.9	40.5
Cost effectiveness (\$/mtCO₂e)	\$103 to \$131		

^a 5 percent discount rate, NPV 2013

However, if biofuel prices continue to track with fossil fuel prices on an energy basis, overall costs may be cost negative. Table 35 illustrates a scenario in which biodiesel achieves and maintains price parity with diesel on an energy basis, and in which ethanol maintains price parity with gasoline on an energy basis. These scenarios all show cost savings, indicating the sensitivity of the cost impact of an LCFS on the future prices of biofuels. Were biofuels able to achieve and maintain price parity with fossil fuels on an energy basis, the cost effectiveness of the LCFS is estimated to be between -\$29 and -\$24 per mtCO₂e.

Table 35: Changes in fuel and vehicle expenditures associated with potential Washington LCFS. Positive values represent increased costs, and negative values represent cost savings

(million \$US)	2020	2035	NPV 2016-2035 ^a
Low CNG Scenario	\$0	\$(15)	\$(41)
Diesel (million \$US)	\$(61)	\$(624)	\$(2,230)
Biodiesel (million \$US)	\$58	\$561	\$2,032
CNG (million \$US)	\$2	\$38	\$120
Vehicles (million \$US)	\$2	\$9	\$38
High CNG Scenario	\$0	\$(42)	\$(116)
Diesel (million \$US)	\$(61)	\$(701)	\$(2,448)
Biodiesel (million \$US)	\$58	\$526	\$1,993
CNG (million \$US)	\$2	106	\$310
Vehicles (million \$US)	\$2	\$9	\$88
Low EV Scenario	\$(19)	\$(286)	\$(951)
Gasoline (million \$US)	\$(1,423)	\$(3,194)	\$(20,281)
Ethanol (million \$US)	\$1,352	\$2,715	\$18,372
Electricity (million \$US)	\$28	\$159	\$671
Vehicles (million \$US)	\$24	\$33	\$41
High EV Scenario	\$(19)	\$(330)	\$(1,072)
Gasoline (million \$US)	\$(1,423)	\$(2,213)	\$(17,532)
Ethanol (million \$US)	\$1,352	\$1,659	\$15,416
Electricity (million \$US)	\$28	\$184	\$740
Vehicles (million \$US)	\$24	\$39	\$287
GHG Reductions (MMTCO₂e)	1.0	3.9	40.5
Cost effectiveness (\$/mtCO₂e)	\$(29) to \$(24)		

^a 5 percent discount rate, NPV 2013

It is also worth noting the types of fuels being purchased. In particular, the decreases all come in the form of gasoline or diesel fuels. Increased expenditures go towards ethanol and electricity in the gasoline pool, both of which can potentially be generated within Washington. For the diesel pool, it is possible based on prior TIAX assessments that a significant portion of the biodiesel requirement could be met from in-state resources; however, natural gas would still be imported. Finally, the scenarios illustrate that by increasing the demand for low carbon biofuels, an LCFS would create an opportunity for in-state feedstocks and growth of the in-state biofuel processing sector. By 2050, modeling indicates that there will be a potential demand for 792 million to 1.65 billion gallons of ethanol, and 363 to 477 million gallons of biodiesel as a result of the LCFS. However, demand and availability of feedstocks are not a guarantee that in-state production will expand to keep pace with LCFS requirements.

Finally, compliance with the LCFS will place a varied burden on different industries. One potential scenario for compliance outlined by the Boston Consulting Group (BCG) is that fossil

fuel suppliers will comply by purchasing LCFS credits from alternative fuel suppliers. BCG places this cost at \$0.33 to \$1.06 per gallon.¹⁹⁷ Although the assumptions underlying the BCG analysis have been questioned,¹⁹⁸ Table 36 provides an estimate of the potential distributional impact that could occur as a result of LCFS if the oil industry were to comply through the purchase of LCFS credits valued at up to \$70 per metric ton CO₂e. These high-end estimates based on a per gallon compliance cost of \$1.06 reflect a potential transfer from the oil industry to alternative fuel suppliers.

Table 36. Potential cost of LCFS to oil industry, and benefit to alternative fuel suppliers, if oil industry compliance is met through purchase of LCFS credits at \$70 per ton CO₂e. (million \$USD)

Scenario	2020	2035	2050
Average of All Scenarios	\$462	\$867	\$643

7.4 Implementation History

This section summarizes low carbon fuel standards implemented in other jurisdictions. The following programs are included:

The California Air Resources Board Low Carbon Fuel Standard Program: Established under California Assembly Bill (AB) 32 and Governor Schwarzenegger's 2007 Executive Order S-01-07, the California LCFS is a performance-based measure that aims to cut the carbon intensity of transportation fuels by at least 10 percent by 2020.¹⁹⁹ Under the standard, which ARB began implementing in 2010, carbon intensity is measured in grams of CO₂ equivalent per mega-Joule (gCO₂e/MJ), and fuel providers must demonstrate that their fuel mix meets the LCFS standards for each annual compliance period through a system of "credits" and "deficits" whereby the carbon intensity of a particular fuel in the portfolio is either lower than or higher than the standard for gasoline or diesel, respectively.²⁰⁰ These intermediate targets are set from a baseline carbon intensity for the fuel mix supplied to the state, with a declining average carbon intensity over time. The performance-based nature in the California LCFS allows for flexibility, as regulated entities can incorporate new or improved technologies into existing production pathways, or develop new production pathways to reduce the carbon intensity of their fuel mix. In addition, credits may be banked and traded on the LCFS market to realize compliance. The

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¹⁹⁹ California Assembly Bill 32, Chapter 488. Accessed July 2013 at: <http://www.arb.ca.gov/fuels/lcfs/ab32.pdf>, and California Office of the Governor, Executive Order EO S-01-07. Accessed July 2013 at: <http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf>

²⁰⁰ California Air Resources Board. *Low Carbon Fuel Standard 2011 Program Review Report*. (December 8, 2011). Page 23. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/workgroups/advisorypanel/20111208_LCFS%20program%20review%20report_final.pdf

California LCFS accounts for emissions associated with both direct and indirect land use change in its development of lifecycle carbon intensities.

There have been several court challenges to the California LCFS surrounding the Constitutionality of the regulation, specifically as it pertains to the Commerce Clause. In the latest action as of the drafting of this document, the 9th U.S. Circuit Court of Appeals had ruled 2-1 that the California LCFS did not violate the Interstate Commerce Clause of the U.S. Constitution on September 18, 2013.²⁰¹

Oregon Low Carbon Fuel Standard Program: The Oregon LCFS was authorized in 2009 under House Bill 2186, and includes a mandate to cut carbon intensity in cars and trucks by 10 percent per gallon by 2025. During the program design process, safeguards such as exemptions, deferrals, and periodic program reviews to protect producers, consumers and regulated parties from unintended negative consequences, such as increased prices were included as important topics to address.²⁰²

HB 1286 contains a sunset provision that would effectively end the LCFS in 2015 unless the legislature votes to override the provision. As of a state Senate vote on July 8, 2013, the LCFS will be allowed to expire in 2015, but the topic may be heard for reconsideration at a short session of the Senate in February 2014.²⁰³ The Oregon Department of Environmental Quality never moved to implement the standards because of the sunset date.

British Columbia Renewable and Low Carbon Fuel Requirements Regulation: British Columbia's LCFS, which was established under the province's Greenhouse Gas Reduction Act (SBC 2008, Chapter 16), applies to all fuels used for transportation in British Columbia, and includes a target of a 10 percent reduction in carbon intensity in those fuels by 2020.²⁰⁴ Transportation fuel suppliers calculate a weighted average carbon intensity for their fuel mix, and there is currently no credit/deficit trading system for trading allowances, though the regulation allows for 'notional transfers' of emissions among suppliers.²⁰⁵ British Columbia's

²⁰¹ Jacobs, J. Appeals court rejects industry challenge to Calif. low-carbon fuel standard. E&E News PM. September 18, 2013. Accessed September 2013 at: <http://www.eenews.net/eenewspm/2013/09/18/stories/1059987472>

²⁰² Oregon Department of Environmental Quality. Oregon Low Carbon Fuel Standards Advisory Committee Process and Program Design. (January 25, 2011). Pages 101-104. Accessed July 2013 at: <http://www.deq.state.or.us/aq/committees/docs/lcfs/reportFinal.pdf>

²⁰³ Zheng, Y. The Oregonian. *Oregon Senate rejects 'clean fuels' bill, a top priority for environmental lobby.* (July 6, 2013). Accessed July 2013 at: http://www.oregonlive.com/politics/index.ssf/2013/07/oregon_senate_rejects_clean_fu.html#incart_river; and Greenwire. E&E Publishing. *State Senate rejects clean fuels bill.* (July 8, 2013). Accessed July 2013 at: <http://www.eenews.net/greenwire/2013/07/08/stories/1059983987>

²⁰⁴ British Columbia Ministry of Energy and Mines. *Renewable & Low Carbon Fuel Requirements Regulation.* Accessed July 2013 at: <http://www.empr.gov.bc.ca/RET/RLCFRR/Pages/default.aspx>

²⁰⁵ Natural Resources Defense Council. *A Comparison of California and British Columbia's Low Carbon Fuel Standards.* (March 2010). Page 4. Accessed July 2013 at: <http://climateactionnetwork.ca/archive/webyp->

LCFS includes only emissions from direct land use change in its development of lifecycle carbon intensities.

Because of regulatory structure, there is a concern that the policy may reduce the use of crudes (such as Canadian oil sands) within the LCFS jurisdiction, but these crudes may still be used elsewhere to produce fuel (with added emissions from additional transportation).²⁰⁶

European Union Fuel Quality Directive: The European Union's Fuel Quality Directive was established in 2009 under Directive 2009/30/EC, and requires the GHG intensity of transportation fuels, specifically petroleum, diesel and biodiesel, to be reduced by up to 10 percent by 2020. The policy includes a binding 6 percent reduction in the GHG intensity of these fuels by 2020 for fuel suppliers, with intermediate targets of 2 percent by 2014 and 4 percent by 2017; the remaining 4 percent of the 10 percent target is non-binding, and contingent upon the development of new technologies such as carbon capture and storage (additional 2 percent reduction on the 10 percent target), and the purchase of credits through the Clean Development Mechanism (CDM) (additional 2 percent reduction on the 10 percent target).²⁰⁷ The EU is currently reviewing the potential to include indirect land use change from biofuels in its Directive.

[system/program/download.php?FILENAME=53-31-at-PDF File Upload 1.pdf&ORG_FILENAME=BC and CA fuel standard comparison FINAL.pdf](#)

²⁰⁶ Natural Resources Defense Council. March 2010.

²⁰⁷ European Commission. *Fuel Quality*. Accessed July 2013 at: http://ec.europa.eu/clima/policies/transport/fuel/index_en.htm

8 Zero Emissions Vehicle Goal

Table 37: Potential Costs and Benefits of a Zero Emissions Vehicle Goal to Washington Consumers and Businesses

Potential Action for Consideration				
<ul style="list-style-type: none"> Consider implementing a ZEV mandate in conjunction with adopting the California Low Emissions Vehicle III Standard (LEV III) to realize benefits from a coordinated package of transportation policies. 				
GHGs and Costs in Washington	GHG Reductions (MMTCO ₂ e)			Cost (\$/mtCO ₂ e) ²⁰⁸
	2020	2035	2050	
22 percent ZEV credit requirement by 2025	0.1	2.0	2.6	\$(70) to \$70
Implementation Issues and Lessons Learned				
<ul style="list-style-type: none"> Potential interactions with a low carbon fuel standard. Other states have implemented ZEV mandates and may get first offerings of ZEVs from manufacturers, including ZEV models not distributed to non-ZEV states; conversely, a ZEV mandate may not increase total U.S. ZEVs, but rather shift sales to Washington. Increases in ZEV model options may increase consumer purchasing. Customer incentives may help meet goals. Since the current sales tax exemption applies only to vehicles fueled solely by electricity, the proposed incentives may shift purchasing to a higher proportion of TZEVs. Unknown costs to vehicle manufacturers and dealerships. Need for additional infrastructure to support ZEVs. 				
Potential Costs and Benefits to WA Consumers		Potential Costs and Benefits to WA Businesses		
<ul style="list-style-type: none"> Public health benefits from reduced emissions. Increase in vehicle prices as a result of incremental vehicle technology prices. California has estimated that the average new vehicle purchase costs will increase by about \$1,900.²⁰⁹ Increased purchase costs are expected to be offset by reduced operating costs, ultimately resulting in a net savings of up to \$4,000 over the lifetime of the vehicles.²¹⁰ Replacing single occupancy gasoline vehicles with single occupancy ZEV/TZEVs will reduce emissions overall, but does nothing to address congestion, which by itself can increase emissions and create tremendous costs to both consumers and businesses. 		<ul style="list-style-type: none"> Opportunities for engineering and manufacturing jobs within the State of Washington.²¹¹ Shifts away from petroleum-based fuels (gasoline and diesel) will have negative impacts on businesses involved in oil production, refining and transportation. Shifts toward electricity produced in-state will have positive impacts on businesses involved in those industries as there will likely be increases in electricity demand from electric vehicle charging. Replacing single occupancy gasoline vehicles with single occupancy ZEV/TZEVs will reduce emissions overall, but does nothing to address congestion, which by itself can increase emissions and create tremendous costs to both 		

²⁰⁸ 5 percent discount rate, NPV 2013

²⁰⁹ (p.147 of the CARB study: <http://www.arb.ca.gov/regact/2012/leviiiighg2012/levisor.pdf>).

²¹⁰ (CARB Study page 209).

²¹¹ (governor's plan page 5: [http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_\(02-13\).pdf](http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf))

consumers and businesses.

Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?

A ZEV mandate targets emissions from the transportation sector. In 2010, the transportation sector in the state of Washington accounted for 44 percent of total GHG emissions.²¹²

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

ZEVs provide an opportunity to reduce transportation emissions without decreasing vehicle usage. Twelve other states have also adopted California's ZEV mandates, but California provides a particularly good example of developing a market and increasing market penetration of ZEVs through the ZEV mandate.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

The ZEV mandate is a discrete and comprehensive policy. California, however, has included the ZEV mandate in a bundle of policies under the Advanced Clean Cars Program, a coordinated policy package that combines standards for smog, GHG emissions, and ZEV adoption.²¹³

Can the policy be meaningfully implemented or influenced at the State level?

Yes, California is currently implementing a ZEV mandate at the state level as a part of the Advanced Clean Cars Program.

8.1 Introduction

In 2010, the transportation sector in the state of Washington accounted for 44 percent of total GHG emissions, the result of combustion of carbon intensive transportation fuels. Zero emissions vehicles (ZEVs) provide an opportunity to reduce transportation emissions without decreasing vehicle usage. The primary ZEVs available today are electric vehicles and plug-in hybrid electric vehicles, both of which utilize electricity in place of gasoline. Despite their name, ZEVs however do cause emissions of GHGs and other pollutants. Whereas traditional vehicles emit GHGs and pollutants out of the tailpipe, the emissions associated with ZEVs are upstream at, for example, electricity generating facilities. Due to scale and regulation, these facilities more effectively manage emissions on a net energy basis. Additionally, less energy is required to operate an electric motor than a gasoline engine. Even when accounting for upstream emissions from electricity generation, the use of ZEVs results in GHG reductions and reductions in smog forming criteria pollutants.

²¹² Department of Ecology. 2012. Washington State Greenhouse Gas Emissions Inventory 1990-2010. Accessed July 2013 online at: <https://fortress.wa.gov/ecy/publications/SummaryPages/1202034.html>

²¹³ California Air Resources Board. 2011. Advanced Clean Cars Summary (page 1). Accessed August 2013 online at: http://www.arb.ca.gov/msprog/clean_cars/acc%20summary-final.pdf

This benefit can be compounded, however, due to Washington's clean energy mix and low GHG emissions in the electricity sector. Because of the relatively clean electricity fuel mix in Washington State due to the large presence of hydropower, transferring transportation energy generation from the vehicle to the power plant has the added benefit of moving the transportation sector away from fossil fuels.

A ZEV mandate is a policy mechanism designed to incentivize ZEVs in the marketplace. Originally adopted in 1990 by California, the ZEV regulation requires automakers to produce and sell a certain number or percentage of passenger and light duty truck ZEVs each year the regulation is in effect. The purpose of this regulation is to encourage the development and commercialization of ZEVs, improve air quality, and reduce GHG emissions. California currently has two ZEV policies in place, one which provides rules up through model year 2017, and a second that covers model years 2018 to 2025. Both of the California rules acknowledge the current challenges in getting true ZEVs onto the road, and provide a mechanism by which automakers can receive partial credits for various advanced vehicles (e.g., partial ZEVs and transitional ZEVs) including ultra clean gasoline, natural gas, hybrids and plug-in hybrids. It is important to note that there is a difference in vehicles that qualify for these credits, namely partial ZEVs (PZEV) and transitional ZEVs. A PZEV is 90% cleaner than the average new model year car, has a 15-year / 150,000 mile warranty, has zero evaporative emissions, and can use non-ZEV fuels (e.g., hybrid electric or gas vehicles).²¹⁴ A TZEV has the same first three qualities as a PZEV, but a TZEV has to use a ZEV fuel such as electricity or hydrogen (e.g., plug-in hybrid electric vehicle or a hydrogen fuel cell vehicle).²¹⁵ This credit arrangement allows automakers to fulfill their obligation with a combination of true ZEVs and other low emitting vehicles. However, this arrangement also means that automakers do not necessarily put the prescribed number of ZEVs on the road, but rather generate a quantity of ZEV credits equal to their obligation.

Section 8.2 provides an overview of work completed to date that analyzes the potential for a ZEV policy in Washington. Section 8.3 provides original estimates of the potential GHG reductions that could be generated through implementation of a ZEV program in Washington based on the most current California standard. Additional background on the California program, its structure, and implementation history is provided in Section 8.4.

²¹⁴ Drive Clean California. California Vehicle Emissions Ratings: PZEV Definition. Accessed August 2013 online at: <http://www.arb.ca.gov/msprog/zevprog/factsheets/driveclean.pdf>

²¹⁵ California Air Resources Board. November 2010. ZEV Regulation 2010: Staff Proposal. Accessed September 2013 online at: http://www.arb.ca.gov/msprog/levprog/leviii/meetings/111610/zev_workshop_presentation_final.pdf

8.2 Literature Review of Washington Potential

In 2008, Washington State's Climate Action Team (CAT) Transportation Implementation Working Group conducted a brief analysis of how implementation of California's 2009-2017 ZEV regulation might impact Washington. The analysis separately projected results for the years 2012-2014, and 2015-2017. The following table provides the results from the 2008 CAT analysis.

Table 38: Number of ZEVs as a result of implementing the 2009-2017 California ZEV standards in Washington.²¹⁶

Vehicle Types	2012-2014 ZEV Requirement	2012-2014 Number of Vehicles	2015-2017 ZEV Requirement	2015-2017 Number of Vehicles
Ultra Clean Gasoline	6%	16,800	6%	16,800
Hybrids and Natural Gas	3%	8,400	2%	5,600
Plug-in Hybrids and Neighborhood Electric Vehicles	2.19%	6,132	3%	8,400
ZEV (full electric or fuel cell)	0.81%	2,268*	3%	4,200*
Total ZEV Obligation	12%	33,600	14%	35,000
Total WA new vehicle sales (2002-2006)		280,000		280,000

*In 2012-2014, ZEVs are not required to be sold in Washington, but some may be voluntarily sold in the state. After 2014, regulations would require some true ZEVs to be placed in Washington, but numbers depend on how manufacturers comply with California.

This analysis projected there to be 33,600 ZEVs sold in Washington from 2012-2014 and 35,000 from 2015-2017. The number of ZEVs registered in Washington in 2012 totaled 2,669.²¹⁷ Furthermore, the CAT suggested that there could be approximately 400,000 mtCO₂e reduced by 2035 as a result of this policy.²¹⁸ The CAT study also estimated costs of a Washington ZEV program to be approximately \$180 million by 2017. Costs will generally be lower as the ZEV technology gets better. Furthermore, the study found that the addition of PZEVs²¹⁹ to the annual targets lowers costs because PZEV technology is more commercialized than ZEV technology such as battery electric vehicles (BEVs) or fuel cell vehicles (FCVs).²²⁰ After considering these results, however, the 2008 Transportation Implementation Working Group chose not to provide a

²¹⁶ Table adapted from: Washington Climate Action Team: Transportation Implementation Working Group. November 2008. Reducing Greenhouse Gas Emissions and Increasing Transportation Choices for the Future Accessed August 2013 online at: http://www.ecy.wa.gov/climatechange/2008CAT_iwg_tran.htm

²¹⁷ 2012 Vehicle registration data provided by WA Department of Ecology

²¹⁸ Washington CAT 2008, page 55.

²¹⁹ PZEVs can include ultra clean gasoline vehicles, hybrid electric vehicles, and neighborhood electric vehicles (NEVs) with limited speed and range.

²²⁰ Washington CAT 2008, page 58-59.

recommendation to Washington on the ZEV standard because there was still uncertainty and mixed opinion over multiple points of the policy.²²¹ Table 39 summarizes some of the main arguments presented in the CAT study as Pros and Cons for a ZEV mandate.

Table 39. Summary of arguments for and against a ZEV mandate, put forth by the 2008 CAT.²²²

Pros	Cons
ZEVs can reduce GHGs, and fewer plug-in hybrids will be delivered to Washington without ZEV requirement.	A ZEV or plug-in hybrid sold in another state has the same effect on global emissions as a ZEV sold in Washington.
Delaying implementation may cause later challenges to manufacturers meeting a future mandate	The market has a greater effect than regulations
The mandate will encourage recharging infrastructure that will enable additional future ZEVs	The infrastructure does not exist, and utilities, businesses, and local governments do not appear willing to build before demonstration of demand. ²²³
Initial ZEV requirements create a pathway speeding arrival of true ZEVs	The market has a greater effect than regulations
Costs are lower than previous estimates	Costs are still very high
Manufacturers will subsidize sales in order to move vehicles from dealers.	Dealers are forced to assume risk of high priced inventory that may not sell

Since the time of the CAT's work in 2008, California has passed additional ZEV standards for 2018-2025. In considering implementing the 2018-2025 ZEV standards, Washington can look to California as an example of the potential economic benefits provided by the ZEV regulation. California attributes their ZEV regulations with increased job creation as a result of automakers such as Tesla targeting the California ZEV market. In 2011, ARB projected a Tesla manufacturing facility in Fremont, California, to create 1,000 jobs alone. Furthermore, California has become a strong job and economic center for the plug-in electric vehicle charging sector, allowing companies to foster an early market for ZEVs with new financing and charging options. According to the state, this innovation and technology advancement spurs consumer costs savings, allowing consumers to spend money to boost local economies and further job creation.²²⁴ These economic benefits could translate to Washington with the implementation of a ZEV standard from 2018-2025. Washington is already benefitting with 80 jobs at the SGL/BMW Automotive Carbon Fiber plant at Port of Moses Lake. This plant is helping to produce, the new BMW i3, an all-electric vehicle.

²²¹ Washington CAT 2008, page 56.

²²² Washington CAT 2008, pages 56-59.

²²³ Note that this was an argument presented at the time of the Washington CAT analysis in 2008. Currently, there is progress in infrastructure penetration into the market as exemplified by the West Coast Green Highway. Details about this highway can be found at: <http://www.westcoastgreenhighway.com/>

²²⁴ CARB Advanced Clean Cars Summary 2011, page 2.

The following section provides an estimate of the potential GHG reductions and selected costs and benefits associated with a ZEV mandate following California's 2018-2025 model.

8.3 Quantification

This section analyzes the potential GHG emission reductions that could be generated from a zero emissions vehicle (ZEV) mandate with supporting purchase incentives. The potential policy is modeled on California's ZEV mandate which extended manufacturer ZEV sales requirements to 2025.²²⁵ Previously, California's ZEV program goals extended only to a level of 16 percent of light duty vehicle sales in 2018, and included a variety of trading mechanisms for meeting this goal through the use of transitional technologies including hybrid vehicles. The 2012 amendments created new requirements for the years 2018 to 2025, and limits the program to ZEVs and transitional zero emissions vehicles (TZEVs). The program sets a total ZEV requirement equal to a percent of passenger cars and light duty trucks sold in the state. Of this percentage, there is a minimum floor that must be met through true ZEVs, with an option to generate credits to fill the remainder through TZEVs. The credit requirements for the ZEV program are shown in Table 40. These credit requirements, however, may not represent the actual number of vehicles may generate more or less than one credit depending upon their characteristics.

Table 40. ZEV Requirements for Large Volume Manufacturers.²²⁶

Model Years	Total ZEV Percent Requirement	Minimum ZEV floor	TZEVs
2018	4.5%	2.0%	2.5%
2019	7.0%	4.0%	3.0%
2020	9.5%	6.0%	3.5%
2021	12.0%	8.0%	4.0%
2022	14.5%	10.0%	4.5%
2023	17.0%	12.0%	5.0%
2024	19.5%	14.0%	5.5%
2025 and subsequent	22.0%	16.0%	6.0%

To help incentivize ZEVs, California also offers incentives for ZEVs equal to \$2,500, and for TZEVs equal to \$1,500. This analysis assumes that Washington would offer these same

²²⁵ CARB, Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.

²²⁶ Ibid.

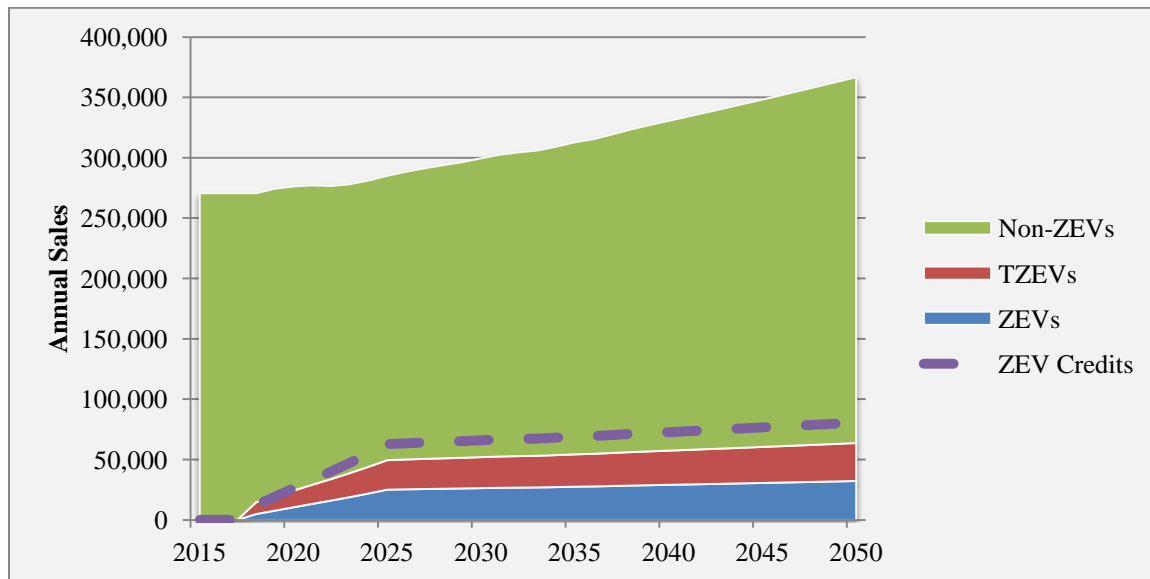
incentive levels through 2025, and that incentives would not extend beyond that date. Given Washington's current sales tax exemptions due to sunset in 2015, Washington may wish to fill the 2016-2017 gap by either beginning to offer incentives or extending the tax breaks in order to ensure that ZEVs remain attractive, and that sales are not delayed.

8.3.1 Methodology

To estimate ZEV sales, this analysis utilized the VISION model created by the Department of Energy's (DOE) Argonne National Laboratory. The model has been created to estimate impacts on energy use, carbon emissions, and vehicle deployment in the U.S. through the year 2050. The model's base case scenario incorporates the Annual Energy Outlook 2012 report for vehicle and fuel forecasts. VISION is the model that DOE uses to estimate potential impacts of various vehicle technologies ranging from light- to heavy-duty vehicles, and traditional and alternative fuels. The model relies on vehicle stock projections to track changes in the fuel or vehicle mix through time. In addition to estimating fuel consumption, emissions, and vehicles, the model can be used to estimate the incremental cost increases associated with alternative fuel vehicles.

To begin, the total number of ZEV credits generated by ZEVs and TZEVs were calculated in order to run VISION under baseline assumptions and assumptions reflecting increased ZEV and TZEVs. The structure of the ZEV mandate does not require a 1:1 ratio of actual vehicles to ZEV credits. Instead, depending on vehicle characteristics, a ZEV or TZEV may generate more or less than 1.0 credits. For example, a ZEV with an electric range of 350 miles or above would generate 4 credits, whereas a ZEV with a range of only 50 miles generates a single credit. Similarly, depending on the all-electric range of a TZEV, it may generate anywhere from 0.4 to 1.3 ZEV credits.

This analysis applies a credit of 2.5 to all ZEVs, representing a battery electric vehicle with a 150 mile range. TZEVs generate 0.7 credits each, which is based on the VISION plug-in hybrid vehicle with a greater than 40 mile range. Based on projected vehicle sales figures, and applying these credit values to reach the ZEV requirement in Table 40, total ZEVs and TZEVs sold per year were calculated. Figure 7 shows the number of ZEV credits required to meet the mandate, and the number of TZEV and ZEVs used to generate these credits. As shown in Figure 7, the number of actual vehicles sold will be considerably lower than the number of credits generated as a result of ZEVs which generate greater than one credit on average.

Figure 7. ZEV credits, ZEVs, and TZEVs required to meet ZEV mandate.

Fleet projections in the VISION model were modified to reflect the increased market share of ZEVs and TZEVs as a result of a ZEV mandate, and the results were compared to the VISION default. This provided an estimate of the changes in fuel consumption resulting from increased market penetration of ZEVs. VISION outputs reflect the entire U.S., and therefore these outputs were scaled to Washington and emissions calculated using Washington-specific emission factors. The scaling factor was calculated as the number of projected passenger cars and light-duty trucks sold in Washington as a portion of these sales for the U.S. in VISION. This was used to create an annual scaling factor representing Washington's approximate share of the market. This scaling factor was then multiplied by total changes in energy across a variety of fuels to estimate anticipated changes in fuel consumption in Washington. This same scaling factor was also applied to the cost of vehicles to estimate the incremental cost of buying ZEVs to meet the ZEV mandate.

Changes in GHG emissions were estimated on a lifecycle basis using carbon intensity values generated by TIAX in their 2011 review of a potential LCFS in Washington. These values for electricity, gasoline, diesel, and various biodiesel and ethanol pathways are provided in Section 6, and are tailored to Washington's electric mix and potential feedstocks. Similarly, changes in energy consumption by fuel were used to estimate the change in fuel costs using Washington-specific price forecasts provided by the State. Calculating GHG emission reductions and costs external to the VISION model allowed the results to be tailored to Washington circumstances representing energy markets and fuel emissions characteristics.

Following California ARB's assumptions in evaluating its 2018-2025 ZEV mandate, this quantification assumes that all incremental technology costs are passed along to the consumer as increased vehicle costs. These costs were calculated by scaling the incremental cost increases

generated in VISION to Washington State by applying the aforementioned scaling factor. Manufacturer compliance costs were estimated at \$500 per vehicle based on California ARB estimates. This value represents the additional compliance cost beyond that required to comply with LEV III. Both vehicle costs and manufacturer costs were annualized across the vehicle life in order to more appropriately align overall costs and benefits.

Incentive payments were calculated by applying a \$2,500 incentive to each ZEV, and a \$1,500 incentive to each TZEVE. Incentives are included as a cost on the government side of the ledger, but a benefit to the consumers. As a result of decreased gasoline consumption, Washington would also lose revenue from its fuel tax.²²⁷

8.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions about the structure of the ZEV mandate policy, the path towards attainment, associated data parameters, and exclusions are included in this analysis:

- The ZEV mandate begins in 2018, increases to 2025, and remains level at 2025 levels through 2050.
- Automakers meet the ZEV mandate using the maximum number of TZEVEs allowed.
- ZEVs generate an average 2.5 credits, and TZEVEs generate 0.7 credits each
- No FCV credits are traveled
- Incentives are offered beginning in 2018, and are provided for each vehicle purchased through 2025. No incentive is offered after 2025.
- Baseline fuel economy increases consistent with LEV III and federal standards, as reflected in VISION
- Vehicle VMT is calculated on an annual basis based on vehicle age in VISION, including rebound effects
- Incremental technology costs calculated within VISION associated with TZEVEs and ZEVs are passed to consumers
- Compliance costs to manufacturers above those related to LEV III are \$500 per vehicle, based on California ARB estimates²²⁸
- All one-time costs are annualized over the vehicle lifetime
- All costs are discounted to 2013 using a 5 percent discount rate

This analysis relies on the data sources summarized in Table 41.

²²⁷ The price forecasts used to calculate savings to consumers include taxes; therefore, tax losses to the government are quantified based on current rates and assessed as a cost.

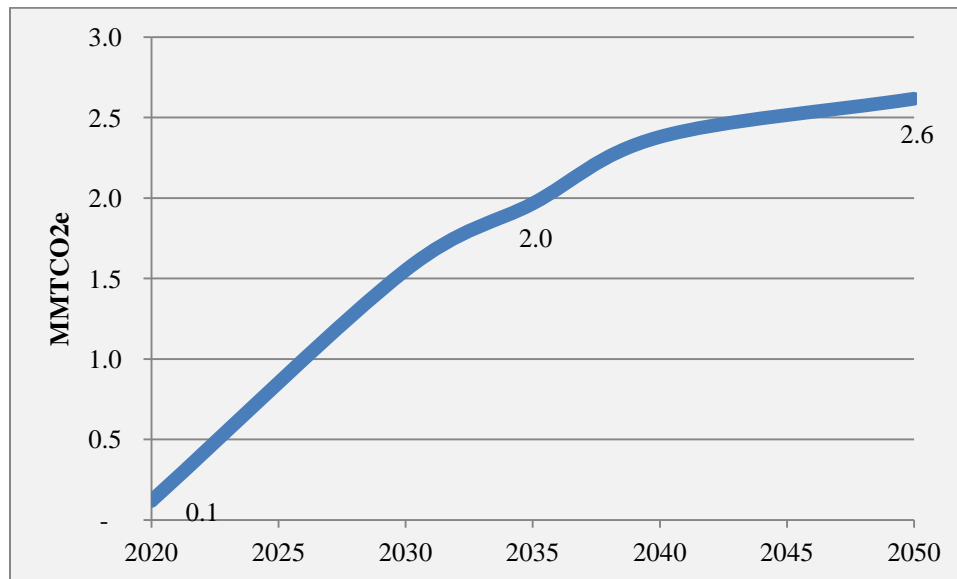
²²⁸ ARB, Initial Statement of Reasons

Table 41. Data sources used in estimating the impact of a ZEV mandate in Washington.

Data	Source
Model	DOE Argonne National Laboratory. 2012. VISION.
Washington Vehicle sales forecasts	Light-duty vehicle sales growth factors from U.S. EIA. "AEO 2013: Light-Duty Vehicle Sales by Technology Type, Pacific Region, Reference Case" applied to new vehicle registration data from National Auto Dealers' Association. "2013 NADA Data, State of the Industry Report."
Baseline Gasoline consumption forecast	OFM Transportation Revenue Forecast Council, Washington State Motor Vehicle Fuel Tax Extended Forecast, June 2013
ZEV mandate requirements	CARB, Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.
ZEV and TZE credit generation rates	CARB, Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.
Lifecycle carbon intensity values	Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011
Incentive payments	CARB. 2013. Implementation Manual for the FY 2012-2013 Clean Vehicle Rebate Project (CVRP). http://energycenter.org/sites/default/files/docs/nav/transportation/cvrp/FY%2012-13%20Implementation%20Manual_FINAL.pdf
Fuel Costs	Personal communication: Washington Department of Ecology, Washington Department of Commerce

8.3.3 Results

Based on the modeled ZEV mandate and supporting incentives, we calculate that Washington could achieve significant GHG reductions while decreasing expenditures on out of state energy sources, and gasoline in particular, with an increase in electricity consumption. Figure 8 shows emissions reductions resulting from the ZEV mandate, which increase over the study horizon, and begin to level out as they approach 2050. Emission reductions are estimated to be 0.1 MMTCO_{2e} in 2020, 2.0 MMTCO_{2e} in 2035, and 2.6 MMTCO_{2e} in 2050.

Figure 8. GHG emission reductions from ZEV Mandate.

As shown in Table 42, the ZEV Mandate is estimated to cumulatively place a combined 58 thousand ZEVs and TZEVS on the road from 2018 to 2020. By 2035 and 2050, the mandate would cumulatively lead to a combined total of 776 thousand and 1.6 million vehicles, respectively. As a result of these vehicles, Washington emission reductions are estimated to be 0.1 MMTCO₂e in 2020, 2.0 MMTCO₂e in 2035, and 2.6 MMTCO₂e in 2050. These emission reductions are the result of decreases in gasoline consumption, which are significantly greater than the GHG emissions incurred as a result of increased electricity use. To accommodate the ZEVs and TZEVS that would result from a ZEV mandate, Washington would need to deliver 2,542 GWH of additional electricity by 2050.

Table 42. Summary of ZEV Mandate impacts on sales of ZEVs, fuel consumption and GHG emissions.

	2020	2035	2050
Cumulative ZEV Sales (thousand)	23	383	833
Cumulative TZEVS Sales (thousand)	35	393	832
Change in Annual Gasoline Consumption (million gallons)	(14)	(210)	(258)
Change in Annual Electricity Consumption (GWH)	246	2,012	2,542
GHG Emission Reductions (MMTCO ₂ e)	0.1	2.0	2.6

Costs of the ZEV Mandate were calculated across a variety of categories including manufacturer compliance costs, consumer technology costs (incrementally more expensive vehicles), and fuel costs. In addition, Table 43 quantifies the incentive payments resulting from a \$2,500 incentive for ZEVs and a \$1,500 incentive for TZEVS, and the decrease change in tax revenue that results

from decreased gasoline consumption. The cumulative 2020-2035 costs reflect net present value in 2013, applying a 5 percent discount rate.

Table 43. Costs of a ZEV Mandate. Positive values represent costs, and negative values represent savings.

Million \$US	2020	2035	NPV 2020-2035 ^a
Cost to Government	\$62	\$74	\$1,160
Incentives Payments	\$57	\$-	\$489
Lost Fuel Tax Revenue	\$5	\$74	\$671
Cost to Manufacturers^b	\$138	\$155	\$2,340
Cost to Consumers	\$(58)	\$(232)	\$(2,333)
Fuel Costs Savings ^c	\$(18)	\$(553)	\$(4,629)
Technology Cost	\$17	\$321	\$2,785
Incentives Received	\$(57)	\$-	\$(489)
Total Costs	\$143	\$(4)	\$1,167
Total GHG Reductions (MMTCO₂e)	0.1	2.0	16.7
Cost per mtCO₂e (including manufacturer costs)			\$70
Cost per mtCO₂e (excluding manufacturer costs)			\$(70)

^a 5 percent discount rate, NPV in 2013

^b This cost may be excluded in recognition of the fact that WA is not a major auto manufacturer

^c Includes fuel tax

Finally, a cost per metric ton CO₂e was calculated for the ZEV Mandate based on the NPV of emission reductions from 2020 to 2035. The resulting cost is highly dependent on whether manufacturer costs are considered (the majority of costs are expected to be passed to consumers, but based on California ARB modeling, some portion of costs will be borne by manufacturers). Including the costs to manufacturers results in a cost effectiveness of \$70 per mtCO₂e. Excluding this cost to manufacturers in recognition of the fact that auto manufacturers are not located in Washington results in a cost effectiveness of \$(70) per mtCO₂e.

8.4 Implementation History

There are currently two ZEV policies in California that regulate the standards for ZEVs from 2009-2017²²⁹ and from 2018-2025²³⁰. The ZEV program for 2018-2025 acts as the focused

²²⁹ California Code of Regulations. Section 1962.1: Zero-Emission Vehicle Standards for 2009 through 2017 Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles. Accessed August 2013 online at:

<http://www.arb.ca.gov/msprog/zevprog/zevregs/zevregs.htm>

²³⁰ California Code of Regulations. Section 1962.2: Zero-Emission Vehicle Standards for 2018 through Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles. Accessed August 2013 online at:

<http://www.arb.ca.gov/msprog/zevprog/zevregs/zevregs.htm>

technology of the Advanced Clean Cars program, a coordinated policy package that combines standards for smog, GHG emissions, and ZEV adoption.²³¹ The following paragraphs briefly discuss the ZEV standards for 2009-2017 and 2018-2025.

The California ZEV requirement for 2009-2017 mandates that particular number/percentage of vehicles that produce no air emissions are delivered and sold in the state. The following table shows the minimum ZEV requirement standards for car manufacturer sales levels for 2009-2017 in California.

Table 44: Minimum ZEV requirement standards as a percentage of car manufacturer sales levels for 2009-2017.²³²

Model Year	Minimum ZEV Requirement
2009-2011	11%
2012-2014	12%
2015-2017	14%

This regulation defines ZEV fuel to include electricity, hydrogen, or compressed air.²³³ Due to the fact that there is a limited market for ZEVs²³⁴ and the fact that more efficient ZEV technology continues to develop, California set the ZEV requirements with the caveat that manufacturers could incorporate PZEVs to meet their targets up until 2018.²³⁵ PZEVs include ultra clean gasoline vehicles, hybrid electric vehicles, and neighborhood electric vehicles (NEVs) with limited speed and range. From 1996-2010, the cumulative vehicle placement from this ZEV regulation resulted in 180 fuel cell vehicles (FCVs), 5,200 battery electric vehicles (BEVs), 28,800 neighborhood electric vehicles (NEVs), 380,000 hybrid or compressed natural gas vehicles, and 1.75 million conventional gas vehicles.²³⁶

The ZEV program for 2018-2025 is part of California's Advanced Clean Cars (ACC) program, a coordinated policy package that combines standards for smog, GHG emissions, and ZEV adoption. The following table shows the minimum ZEV requirement standards for car manufacturer sales levels for 2018-2025.

²³¹ California Air Resources Board. 2011. Advanced Clean Cars Summary (page 1). Accessed August 2013 online at: http://www.arb.ca.gov/msprog/clean_cars/acc%20summary-final.pdf

²³² Table adapted from: California Code of Regulations Section 1962.1, page 1.

²³³ Table adapted from: California Code of Regulations Section 1962.1, page 31.

²³⁴ Limited market here means that ZEVs do not compare to standard gasoline and diesel vehicles in terms of affordable vehicles with customary range, speed, and refueling capability.

²³⁵ Table adapted from: California Code of Regulations Section 1962.1, page 5.

²³⁶ CARB Advanced Clean Cars Summary 2011, page 11.

Table 45: Minimum ZEV requirement standards as a percentage of car manufacturer sales levels for 2018-2025.²³⁷

Model Year	Minimum ZEV Requirement
2018	4.5%
2019	7.0%
2020	9.5%
2021	12.0%
2022	14.5%
2023	17.0%
2024	19.5%
2025 and after	22.0%

There are progress and challenges as California has seen and encountered over its time of implementing the ZEV regulations. California represents 40 percent of the U.S. market for plug-in electric vehicles, and automakers are hoping to integrate FCVs into California starting in 2015. The ZEV mandate and funding through programs such as purchase and infrastructure incentives have spurred growth and technological advances in the ZEV market through California companies. Communication between utilities, local governments and communities has strengthened private-public partnerships to create strategies to overcome challenges to ZEV adoption.²³⁸ Challenges include investing in easily-accessible and cost effective ZEV infrastructure, ZEV performance, commercialization of ZEVs across all vehicle categories, reducing the high up-front costs to purchase ZEVs, and raising consumer awareness.²³⁹

In the 2013 California Governor's ZEV Action Plan, California has set a goal to have 1.5 million ZEVs on the road by 2025. This plan outlines steps on a five year basis from 2015-2025 to implement and streamline infrastructure plans and permitting, encourage private investment and manufacturer production of ZEVs, keep ZEV costs competitive with conventional combustion vehicles, and ensure that there will be mainstream access of ZEVs to consumers.²⁴⁰ With the ZEV regulations and this action plan, California has set a practical example that Washington could build upon if the State chooses to adopt the 2018-2025 ZEV standards.

²³⁷ Table adapted from: California Code of Regulations Section 1962.2, page 1.

²³⁸ California Governor's Interagency Working Group on Zero-emission Vehicles. February 2013. ZEV Action Plan: A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025. Accessed September 2013 online at: [http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_\(02-13\).pdf](http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf), page 3.

²³⁹ California Governor's Interagency Working Group on Zero-emission Vehicles 2013, page 6.

²⁴⁰ California Governor's Interagency Working Group on Zero-emission Vehicles 2013, page 2.

9 Renewable Fuel Standard and Supporting Policies

Potential Action for Consideration				
Strengthen Washington’s existing RFS from a volumetric 2 percent to a universal 5 percent biodiesel requirement. To support this goal, extend existing incentives (or their equivalent) for alternative fuel vehicles, biofuel production and distribution, and infrastructure beyond current expiration dates.				
GHGs and Costs in Washington	GHG Reductions (MMTCO ₂ e)			Cost (\$/mtCO ₂ e)
	2020	2035	2050	
5 percent universal biodiesel requirement	0.2	0.4	0.4	Not quantified
Implementation Issues and Lessons Learned				
<ul style="list-style-type: none">• Volumetric renewable fuel standard requirements are difficult to enforce. Changing from a volumetric requirement to a universal requirement for each gallon of diesel fuel sold would require each gallon of fuel to contain the specified percent biodiesel. This can be verified by random testing, alleviating the administrative burden of a volumetric requirement and simplify enforcement.• Align policies to ensure that biofuel incentives and tax breaks are mutually supportive.• Economic studies in Washington recommend implementing a carbon tax to spur the advancement and market penetration of biofuels. Results indicated that GHG-based price incentives can provide a foundation for the diversification of motor fuels, encourage advanced research and development of biofuel technology and infrastructure, and incentivize the state energy industry to invest further in biofuel production and fueling support.				
Potential Costs and Benefits to WA Consumers		Potential Costs and Benefits to WA Businesses		
<ul style="list-style-type: none">• Public health benefits from reduced emissions.^{241,242}• Consumers receive incentives for their purchase and use of AFVs, generally reducing the up-front cost of the vehicle. Consumers may incur the cost of interest on loans received to purchase an AFV.		<ul style="list-style-type: none">• Opportunities for engineering and manufacturing jobs within the State of Washington associated with biofuel infrastructure.• Shifts away from petroleum-based fuels (e.g., gasoline and diesel) will have negative impacts on businesses involved in oil refining and transportation.		
Summary of Screening Criteria				
<p><i>Does the policy target an emissions source of significant magnitude in Washington?</i></p> <p>The transportation sector in the state of Washington accounted for 44 percent of total emissions in Washington in 2010. These emissions are the result of combustion of transportation fuels, so the implementation of a progressive RFS along with AFV incentives to purchase vehicles and increase infrastructure would have a corresponding effect on emissions from transportation fuel combustion.</p> <p><i>What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?</i></p> <p>Several AFV incentive programs in other states (e.g., California, Illinois, and New York) have reduced</p>				

²⁴¹ NYSEDA/New York City Clean-Fueled Bus Program Case Study: Hybrid-electric and Natural Gas Buses. Online at: <http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx>

²⁴² Illinois Green Fleets: Green Jobs, Clean Diesel, Clean Air. 2009. A Grant Application submitted to the U.S. Environmental Protection Agency-Region 5 by the Illinois Environmental Protection Agency, the American Lung Association of Illinois, and the Respiratory Health Association of Metropolitan Chicago on behalf of the Illinois Clean Diesel Workgroup, (page 10). Online at: <http://www.recovery.illinois.gov/documents/Applications/IEPA%2066.039%20National%20Clean%20Diesel.pdf>

emissions and been considered successful. Most notably, the California Energy Commission's (CEC) Alternative and Renewable Fuel and Vehicle Technology Program has awarded \$64 million to biofuels through the first two investment plans, and an additional \$76 million is being allocated to biofuels and alternative fuel production in the 3rd and 4th investment plans as of December 2011. The CEC estimates annual carbon emission reductions from biofuel production projects by 2020 to be between 1.3 MMTCO₂e and 6.8 MMTCO₂e.²⁴³ A detailed analysis of other jurisdictional incentives can be found in Appendix A.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

A RFS is a discrete policy targeting the State's fuel mix. Supporting AFV, biofuel production, and infrastructure support policies represent a bundle of policies to support the RFS. Incentives target different sectors of the AFV market in an effort to commercialize alternative fuel production and increase use of renewable fuels.

Can the policy be meaningfully implemented or influenced at the State level?

Washington has already implemented an RFS and several AFV and biofuel-associated tax exemptions, loans, and grants at the state level.

9.1 Introduction

Fuel consumption in the transportation sector is the largest source of emissions in the State of Washington. Transportation activities resulted in 42.2 MMTCO₂e of emissions, or 44 percent of total emissions in Washington in 2010. The largest share of emissions from this source resulted from consumption of on-road gasoline and diesel (21.9 and 8 MMTCO₂e, respectively), making incentives to purchase alternative-fuel vehicles (AFVs) and increase fueling and support infrastructure important steps to reducing on-road GHG emissions.

Renewable fuels generally have lower lifecycle emissions than their fossil fuel counterparts, and present an opportunity to reduce on-road emissions. While some ethanol pathways have higher lifecycle emissions than gasoline, biodiesel is consistently a lower-carbon alternative to diesel. Washington's existing RFS rules impose a 2 percent volumetric requirement for biodiesel as a portion of total diesel sales. To date, Washington's compliance is well below this level, and strengthening the RFS to increase compliance, as well as increasing the requirement to 5 percent, represents an opportunity to decrease diesel emissions in the State.

In addition to the Washington RFS, ancillary policies that encourage production of alternative fuels and create support infrastructure can ease the path to RFS compliance. Many of these programs encourage alternative fuels such as electricity or hydrogen in addition to biodiesel.

²⁴³ California Energy Commission. Benefits report for the Alternative and Renewable Fuel and Vehicle Technology Program (December 2011). Online at: <http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf> (page 26)

Electric vehicles were considered previously in the context of the ZEV mandate, and are not included in this discussion.

9.2 Literature Review of Washington Potential

Currently, the State of Washington has an RFS requiring 2 percent biodiesel as a portion of overall diesel sales, provides certain tax exemptions for AFVs, and provides loans and grants for research and development in the production of alternative fuels.^{244,245} Biofuel and its supporting infrastructure must be cost-effective in order for widespread use of biofuels to thrive. The following list provides brief descriptions of the major State policies currently in place for renewable fuel production, market integration, and infrastructure:

Renewable Fuel Standard: Washington has a statewide Renewable Fuels Standard (RFS) that sets minimum sales percentages of ethanol and biodiesel.²⁴⁶ The standard requires that by November 30, 2008, biodiesel must represent 2 percent of all diesel fuel sold in the State. The share rises to 5 percent when Washington's feedstock production and processing capacities can satisfy a 3 percent requirement. The state ethanol standard has already been met as a result of the fuel quantities required by the Federal RFS2 program. However, the state requirement for biodiesel has not been met, as biodiesel represents less than 1 percent of all diesel sold in the state.²⁴⁷ To meet a 5 percent goal, the rule could be changed from a volumetric requirement to a universal requirement for each gallon of diesel fuel sold. This would require each gallon of fuel to contain the specified percent biodiesel. This can be verified by random testing which would alleviate the administrative burden of a volumetric requirement and simplify enforcement. The change would also mirror Oregon's RFS, which moved to a 5 percent universal biodiesel requirement in 2011, and create a uniform regional policy framework and fuel distribution system as Oregon relies on Washington for the bulk of its fuel supply.²⁴⁸

Alternative Fuel Loans and Grants: Administered by Washington's Department of Commerce in consultation with other state agencies, the Energy Freedom Program offers loans through the Energy Freedom Account that provide financial and technical assistance for bioenergy research, production, and market development. Loans allow for the conversion of farm products, organic

²⁴⁴U.S. DOE EERE. Alternative Fuels Data Center (AFDC) (Washington- and policy- specific database query). Accessed July 2013 at: [http://www.afdc.energy.gov/laws/search?p=search&location\[\]=WA&search_button=y](http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y)

²⁴⁵ For a complete summary of Washington's biofuels incentives, see: BioEnergy Washington. 2009. Washington State Bioenergy Policy Framework. Accessed July 2013 online at: <http://www.bioenergy.wa.gov/BiofuelIncentives.aspx>

²⁴⁶ Codified as RCW 19.112

²⁴⁷ Washington State Department of Ecology, 2010 Comprehensive Plan, Appendix 2: Washington Policies to Reduce Greenhouse Gas Emissions, Accessed September 2013 at http://www.ecy.wa.gov/climatechange/docs/ccp_appendix2.pdf

²⁴⁸ Washington State Department of Commerce. 2013 Biennial Energy Report. <http://www.commerce.wa.gov/Documents/2013-biennial-energy-report.pdf>

wastes, cellulose and biogas to electricity, biofuel, and other products. The Green Energy Incentive Account through this program also provides financial assistance for alternative fueling infrastructure along interstates. The programs will expire June 30, 2016.²⁴⁹

Biofuels Distribution Tax Exemption and Deduction: Expiring July 1, 2015, the retail sales and use tax exemption applies to fuel delivery vehicles, machinery, equipment, and related services that are used for the retail sale or distribution of blends of 20 percent biodiesel or greater or E85 motor fuel.²⁵⁰ Washington also implements a business and occupation tax deduction for the sale or distribution of biodiesel or E85 motor fuel also expiring July 1, 2015.²⁵¹

Biofuels Production Tax Exemption: Washington exempts qualifying buildings, equipment, and land used for the manufacture of alcohol fuel, biodiesel, or biodiesel feedstocks from state and local property and leasehold excise taxes. This exemption lasts for six years from the date the facility or addition to the existing facility becomes operation. This incentive expires December 31, 2015.²⁵²

Biodiesel Feedstock Tax Exemption: Washington exempts waste vegetable oil (i.e., cooking oil gathered from restaurants or commercial food processors) used to produce biodiesel for personal use from state sales and use taxes.²⁵³

Based on the incentives already in place, Washington has made strides towards increasing the adoption of alternative fuels in the state and being a leader in this space. However, many of these incentivizing policies are slated to expire in the next several years. Extending these policies or their equivalent could help maintain Washington's momentum, and provide certainty over the future economic landscape to consumers and businesses.

The 2012 Washington State Energy Strategy outlines the current biofuels production incentives and recommends that a comprehensive biofuel incentives study be completed to rationalize Washington's biofuel policy.²⁵⁴ Understanding the economic and environmental impacts of biofuel incentives will allow Washington to deploy a harmonized set of policies to reduce GHG

²⁴⁹ RCW 43.325. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: [http://www.afdc.energy.gov/laws/search?p=search&location\[\]=WA&search_button=y](http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y)

²⁵⁰ RCW 82.08.955 and 82.12.955. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: [http://www.afdc.energy.gov/laws/search?p=search&location\[\]=WA&search_button=y](http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y)

²⁵¹ RCW 82.04.4334. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: [http://www.afdc.energy.gov/laws/search?p=search&location\[\]=WA&search_button=y](http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y)

²⁵² RCW 82.29A.135, 84.36.635 and 84.36.640. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at:

[http://www.afdc.energy.gov/laws/search?p=search&location\[\]=WA&search_button=y](http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y)

²⁵³ RCW 82.08.0205 and 82.12.0205. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: [http://www.afdc.energy.gov/laws/search?p=search&location\[\]=WA&search_button=y](http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y)

²⁵⁴ 2012 Washington State Energy Strategy (page 37).

emissions and increase biofuel use. A 2011 study published in the *Journal of Agricultural and Resource Economics* modeled the economic and environmental effects of Washington State biofuel policy alternatives.²⁵⁵ Results indicated that blend mandates and carbon-based fuel taxes were the only policy options that yielded net CO₂e emissions as a result of decreased fossil fuel consumption and the substitution of biofuel into the transportation fuel mix. The model results suggested that biofuel subsidies may reduce the overall price of fuel to make it more competitive in the marketplace such that there will be an increase the quantity demanded for fuel and, subsequently, increases GHG emissions. With regards to economic impacts, results showed that subsidies would increase household income while fuel taxes decrease household income and increase state revenue.²⁵⁶ A recurrent theme in this study is that policy implementation will depend on the priorities of the State. For example, if reducing carbon emissions is the top priority, blend mandates such as the RFS and carbon-based fuel taxes such as those discussed in previous sections, would be particularly cost effective. Furthermore, results indicated that blend mandates, feedstock subsidies, and a revenue-neutral subsidy policy would be important for prioritizing production of biofuels and feedstocks.²⁵⁷

A 2010 study completed by Washington State University on Biofuel Economics and Policy in Washington State did a similar analysis as presented above, and recommended targeting GHGs through a carbon tax²⁵⁸ as the most effective method to address biofuel issues in Washington. GHG-based price incentives can provide a foundation for the diversification of motor fuels, encourage advanced research and development of biofuel technology and infrastructure, and incentivize the state energy industry to invest further in biofuel production and fueling support. The study urges the state to focus on the demand side of biofuel markets by targeting consumer incentives that promote increased consumption of biofuels in place of petroleum-based fuels.²⁵⁹ Washington has made productive progress with the existing RFS, tax exemptions and loan and grant programs. However, in addition to strengthening the RFS, a comprehensive biofuel incentives evaluation study could be completed to better understand and rationalize the impacts of Washington's biofuel policies and incentives and bring about a harmonized suite of policies.²⁶⁰

²⁵⁵ McCullough, M., Holland, D., Painter, K., Stodick, L., and J. Yoder. 2011. Economic and Environmental Impacts of Washington State Biofuel Policy Alternatives. *Journal of Agricultural and Resource Economics* 36(3), pages 615-629.

²⁵⁶ McCullough et al. 2011 (page 617, 628).

²⁵⁷ McCullough et al. 2011 (page 628)

²⁵⁸ This Task 2 report provides a detailed analysis of a carbon tax.

²⁵⁹ Yoder, J., Shumway, R., Wandschneider, P., and D. Young. 2010. Biofuels Economics and Policy for Washington State. Washington State University School of Economic Sciences, p. 117. Accessed July 2013 online at: <http://cru.cahe.wsu.edu/CEPublications/XB1047E/XB1047E.pdf>

²⁶⁰ 2012 Washington State Energy Strategy (page 37).

9.3 Quantification

This section analyzes the potential GHG emission reductions from the implementation of a viable RFS for biodiesel in Washington. The current RFS policy has proven difficult to implement and enforce. The standard requires that the minimum fraction of total annual sales of diesel fuel consist of biodiesel or renewable diesel. This volumetric requirement necessitates tracking of all blendstocks entering into the fuel supply throughout the year which has resulted in an administrative challenge. In addition, there is no requirement for any individual company to comply which has resulted in the standard being difficult to enforce.²⁶¹ As of 2012 the requirement has not been met and biodiesel levels were less than 1 percent of total sales.²⁶² The GHG reductions associated with the current levels of biodiesel are quantified in Task 1 (modeled as biodiesel representing one half of one percent of all diesel fuel). This section quantifies the additional emissions reductions from the RFS assuming that it is amended to a universal 5 percent biodiesel requirement and is modeled as biodiesel representing an additional 4.5 percent in addition to the half percent already in the supply.

9.3.1 Methodology

Emissions reductions were estimated using projections of diesel consumption and projections of biodiesel consumption in the transportation sector in Washington. Most diesel fuel is consumed in the transportation sector which accounted for almost 80 percent of diesel consumption in the state in 2010. Projections of diesel consumption to 2040 were provided by the Office of Financial Management Transportation Revenue Forecast Council. These projections were extrapolated to 2050 using the average growth rate for the last five years of the forecast period. This analysis assumes that the RFS is amended to a universal 5 percent biodiesel requirement.

Consumption of biodiesel was projected to 2020, 2035, and 2050 using the assumption that a requirement of 5 percent biodiesel will be met, but not exceeded, in the target years. This analysis accounts for an additional 4.5 percent of biodiesel consumption to reach the 5 percent requirement. GHG emissions reductions were calculated by multiplying the gallons of diesel avoided by the carbon intensity for diesel fuel and adjusting for the carbon intensity of biodiesel. The energy density of biodiesel is lower than that of diesel and therefore more biodiesel is needed to meet the original demand, also referred to as the energy economy ratio (EER). However, this difference is negligible at low-level biodiesel blends up to B5. For the purposes of this analysis B5 is assumed to have an EER of 1.0 compared to diesel.

²⁶¹ Washington State Department of Commerce. 2012 Washington State Energy Strategy.

²⁶² Email correspondence with Mary Beth Lang, Bioenergy and Special Projects Coordinator., Washington State Department of Agriculture. July 29, 2013.

The principal feedstocks used to produce biodiesel consumed in Washington are Midwest soybeans, Northwest canola oil, and waste grease.²⁶³ A small percentage of biodiesel produced from corn oil is also expected to enter the market in the future.²⁶⁴ Carbon intensities for regular diesel and biodiesel were adapted from the report *A Low Carbon Fuel Standard in Washington: Informing the Decision* prepared by TIAX LLC in February 2011.²⁶⁵ The carbon intensity for corn oil was taken from the California Low Carbon Fuel Standard (LCFS)²⁶⁶ as the TIAX report did not provide a specific carbon intensity for this pathway.²⁶⁷ Table 46 below shows the carbon intensities used for fuels in this analysis.

Table 46. Carbon Intensity Values for Diesel and Biodiesel Fuels

Fuel	Carbon Intensity (gCO ₂ e/MJ)
Baseline Diesel	92
Biodiesel, MW Soybeans	68
Biodiesel, NW Canola	26
Biodiesel, Waste Grease	20
Biodiesel, Corn Oil	4

Source: TIAX LLC. *A Low Carbon Fuel Standard in Washington: Informing the Decision*. Adapted from Table 5-6. Corn oil carbon intensity from California LCFS.

There may be GHG emissions associated with land use when new land is brought into cultivation to replace crops used in biofuel production. These emissions are referred to as indirect land use change (ILUC) and can occur with increased biofuel production. The carbon intensities used in this analysis include ILUC where applicable.²⁶⁸

Table 47 shows the assumed share of biodiesel produced from each feedstock in Washington in the target years.²⁶⁹ The share of each biodiesel feedstock was used to determine the average biodiesel carbon intensity for each target year. It is likely that advanced biofuels, including renewable biodiesel and other advanced conversion pathways, will be available to the Washington market in increasing quantities in the future, particularly in 2035 and 2050.

²⁶³ Washington State Department of Commerce. 2012 State Energy Strategy. Phone conversation with Department of Commerce, Peter Moulton.

²⁶⁴ Phone conversation with Peter Moulton, Department of Commerce.

²⁶⁵ TIAX LLC. *A Low Carbon Fuel Standard in Washington: Informing the Decision*. Adapted from Table 5-6. http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf.

²⁶⁶ California Air Resources Board (ARB), Low Carbon Fuel Standard. <http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf>

²⁶⁷ Note that CARB is planning revise the carbon intensity for corn oil in the near future and it is expected to increase, however, the magnitude of the increase is unclear until the revised intensity is published.

²⁶⁸ MW soybeans is the only biodiesel pathway that includes ILUC in the TIAX report.

²⁶⁹ Email correspondence with Peter Moulton, Department of Commerce, August 22, 2013.

Advanced biofuels will most likely have lower carbon intensities, which would reduce the average carbon intensity of biodiesel and help to increase GHG reductions. However, assumptions regarding the availability and level of adoption of these fuels are highly uncertain. To approximate the decreasing carbon intensity of biodiesel this analysis assumes an increase in the target years of biodiesel produced from canola oil, waste grease, and corn oil, and a reduction in biodiesel produced from MW soybeans. Biodiesel fuels produced from canola, waste grease, and corn oil all have lower carbon intensities than biodiesel produced from MW soybeans as shown in Table 47.

Table 47. Share of Biodiesel Fuel Consumed in Target Years

Fuel	Ratio of Biodiesel Fuel in Target Years			
	2013	2020	2035	2050
Biodiesel, MW Soybeans	0.50	0.35	0.20	0.15
Biodiesel, NW Canola	0.25	0.30	0.35	0.40
Biodiesel, Waste Grease	0.25	0.30	0.35	0.35
Biodiesel, Corn Oil	0.00	0.05	0.10	0.10
Average Biodiesel CI (gCO₂e/MJ)		37.8	30.1	28.0

9.3.2 Assumptions, Exclusions, and Data Sources

The GHG emission reductions associated with the RFS for biodiesel were projected for the target years utilizing the following assumptions:

- Legislative action is taken to modify the RFS from the existing volume-based standard to a universal 5 percent biodiesel standard that is enforceable and practicable.
- A 5 percent biodiesel requirement is met, but not exceeded, in the target years.
- Primary feedstocks for biodiesel consumed in Washington are Midwest soybeans, Northwest canola, and waste grease. Canola and waste grease quantities increase through the target years and small amount of corn oil is included in 2035 and 2050.

This analysis relies on the data sources summarized in Table 48.

Table 48. Data Sources Used to Estimate Emission Reductions from an RFS in Washington

Data	Source
Diesel consumption projections 2014-2040	Transportation Revenue Forecast Council. Email correspondence with Office of Financial Management, Transportation Revenue Forecast Council, August 22, 2013.
Carbon intensities for	TIAX LLC. A Low Carbon Fuel Standard in Washington: Informing the Decision. Adapted from Table 5-6.

fuels	http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf . The carbon intensity for corn oil is from the California LCFS: California Air Resources Board (ARB), Low Carbon Fuel Standard.
Energy density for diesel	California Air Resources Board (ARB), Low Carbon Fuel Standard. Look up Tables. (http://www.arb.ca.gov/fuels/lcfs/lu_tables_11282012.pdf , and http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf)

9.3.3 Results

Based on the method outlined above, total projected diesel consumption and biodiesel consumption and the estimated GHG emission reductions associated with an additional 4.5 percent biodiesel consumption to reach a 5 percent biodiesel requirement in 2020, 2035, and 2050 are shown in Table 49.

Table 49. Emissions Reductions Associated with an RFS for Biodiesel, achieving a net increase of 4.5 percent biodiesel relative to current attainment.

Target Year	2020	2035	2050
Diesel avoided (million gallons)	34	43	52
Emissions from Diesel (MMTCO ₂ e)	0.4	0.5	0.6
Biodiesel required (million gallons)	34	43	52
Emissions from Biodiesel (MMTCO ₂ e)	0.2	0.2	0.2
Net Reduction in CO₂e (MMTCO₂e)	0.2	0.4	0.4

9.4 Implementation History

9.4.1 Renewable Fuels Standards

Washington Renewable Fuel Standards: The Washington Legislature passed a RFS in 2006. The standard requires that, starting in 2008, at least 2 percent of total gasoline sold in the state must be denatured ethanol and at least 2 percent of total diesel fuel sold in the state must be biodiesel or renewable diesel.²⁷⁰

The ethanol requirement has effectively been superseded by the introduction of ethanol content requirements under the Federal renewable fuel standard. The Federal standards have led to a current average ethanol content of just over 9 percent in Washington, 7 percent over the state's 2 percent requirement. Washington consumed over 2.5 billion gallons of motor gasoline in

²⁷⁰ Note that this standard was designed to increase to 5% 180 days after the Washington State Department of Agriculture (WSDA) determines that in-state feedstocks and oil-seed crushing capacity can meet a 3% requirement.

2011.²⁷¹ With a 9 percent average ethanol content, annual motor gasoline reductions resulting from the ethanol component of RFS2 can be approximated at about 230 million gallons. Further analysis of the Federal RFS is included in the Federal Policy Analysis conducted in Task 3 of this project.

The biodiesel portion of the requirement has proven difficult to implement and enforce. The standard requires that the minimum fraction of total annual sales of diesel fuel consist of biodiesel or renewable diesel. This volumetric requirement necessitates tracking of all blendstocks entering into the fuel supply throughout the year which has resulted in an administrative challenge. In addition, there is no requirement for any individual company to comply which has resulted in the standard being difficult to enforce.²⁷² As of 2012 the requirement has not been met and biodiesel levels were less than 1 percent of total sales.²⁷³

The RFS legislation as written is designed to increase the biodiesel requirement to 5 percent of total annual diesel fuel sales when the state determines that both in-state oil seed crushing capacity and feedstock grown in Washington State can satisfy a 3 percent requirement.²⁷⁴ Diesel that contains 5 percent biodiesel, known as B5, is already sold in certain markets in Washington and petroleum fuel distributors are continuing to add biodiesel storage and blending infrastructure to support biodiesel requirements in Oregon and British Columbia, which are largely dependent on Washington refineries and distributors for their fuel supply.²⁷⁵ Prices for B5 have become cost competitive and in some cases have been less expensive than regular diesel. In April 2013, B5 was \$0.62 per gallon less than the average diesel price.²⁷⁶

Efforts have been made to modify the existing biodiesel standard from a 2 percent volumetric requirement to a 5 percent universal requirement, similar to the RFS implemented in Oregon. A universal standard requires all diesel fuel sold at the pump to contain the minimum fraction of biodiesel. This can be verified by random testing which would alleviate the administrative burden of a volumetric requirement and simplify enforcement. However, recent attempts to implement this change during the 2012 legislative session were unsuccessful.²⁷⁷

²⁷¹ Data provided by Department of Commerce in comment on draft version.

²⁷² Washington State Department of Commerce. 2012 Washington State Energy Strategy.

²⁷³ Email correspondence with Mary Beth Lang, Bioenergy and Special Projects Coordinator., Washington State Department of Agriculture. July 29, 2013.

²⁷⁴ RCW 19.112.110. <http://apps.leg.wa.gov/RCW/default.aspx?cite=19.112.110>

²⁷⁵ Washington State Department of Commerce. 2012 State Energy Strategy. <http://www.commerce.wa.gov/Documents/2012WASateEnergyStrategy.pdf>

²⁷⁶ Washington State Department of Transportation. The Fuel and Vehicle Trends Report. April 30, 2013. <http://www.wsdot.wa.gov/NR/rdonlyres/5EDEBF3D-4617-4A51-ADB7-61842F1ABC02/0/FuelandVehicleTrendsApr2013.pdf>

²⁷⁷ House Bill 2740. <http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2740&year=2011>

Federal Renewable Fuels Standard (RFS-1 and RFS-2): The Renewable Fuels Standard (RFS) was created under EPACT 2005. EPACT required that 7.5 billion gallons of renewable fuels be blended into motor gasoline by 2012. Administered by EPA, the original RFS is often referred to as RFS-1. The Program was expanded under EISA 2007. In addition to motor gasoline, it now includes diesel fuels. The target for renewable fuel to be blended into transportation fuels was raised to 36 billion gallons by 2022. EISA established new categories of renewable fuels including biomass-based diesel, non-cellulosic advanced and cellulosic biofuel, each with its own target within the larger overall target. Together, these advanced biofuels were equal to 21 billion of the overall 36 billion gallons targeted in 2022. EISA also set thresholds for the life-cycle GHG emissions of each of these fuels. To qualify under the program, traditional renewable fuels would need to have life-cycle emissions that are 20 percent lower than the fuel being displaced, advanced biofuel and biomass-based diesel would need to have lifecycle emissions 50 percent below the fuel being displaced, and cellulosic biofuel would need to have life-cycle GHG emissions 60 percent below the gasoline or diesel fuel it displaces. Under this Program (now referred to as RFS-2) the EPA assigns refiners and importers of petroleum-based transportation fuels a Renewable Volume Obligation (RVO). These regulated entities may meet these obligations with Renewable Identification Numbers (RIN), an alphanumeric code assigned to each gallon of renewable fuel either produced or imported into the United States. RINs may be traded so that obligations can be met at least cost.

The EPA estimated that RFS-2 will displace approximately 13.6 billion gallons of motor gasoline and diesel fuel in 2022, reducing greenhouse gas emissions by 138 million metric tons, and decreasing the cost of oil imports by \$41.5 billion. At the same time, the program will increase farm income by \$13 billion dollars in 2022, but will also increase the annual cost of food by \$10 per person in the U.S.²⁷⁸ In 2011 and 2012, the American Petroleum Institute commissioned a two-phase study to look at the economic impacts of RFS-2. In phase one, Charles River Associates used the NEMS version from *Annual Energy Outlook 2011* to evaluate the market's ability to absorb ethanol into petroleum based fuels. They estimated that by 2013 the U.S. market would no longer be able to absorb the requisite volume of ethanol and would have to begin either reducing production of petroleum based fuels or increasing the portion of production that was exported.²⁷⁹ Further, Charles River found that by 2015, implementation of the rule would be impossible. In phase two, NERA economic consulting looked at the economic

²⁷⁸U.S. EPA Office of Transportation and Air Quality. February 2010. EPA Finalizes Regulation for the National Renewable Fuel Standard Program for 2010 and Beyond. EPA-420-F-10-007.

²⁷⁹ Foster, H., Bron, R., and P. Bernstein at Charles River Associates. November 2, 2011. Impact of the Blend Wall Constraint in Complying with the Renewable Fuel Standard. H. Foster, R. Baron, P. Bernstein,. Accessed August 2013 online at: http://www.api.org/news-and-media/news/newsitems/2013/march-2013/~/_media/Files/Policy/Alternatives/13-March-RFS/CRA_RSf2_BlendwallConstraints_Final_Report.pdf

effects of hitting this “blend wall,” and concluded that it would result in a \$770 billion decline in GDP in 2015, and a diminution of household consumption of \$2,700.²⁸⁰

What these studies fail to emphasize is that under EISA, the EPA has considerable discretion to alter the individual standards or provide waivers to fuel producers and exporters. In his June 26, 2013 testimony to the House Committee on Energy and Commerce, Subcommittee on Energy and Power, EIA Administrator Adam Sieminski stated that “the RFS program is not projected to come close to the achievement of the legislative target that calls for 36 billion gallons of renewable motor fuels use by 2022.” He went on to state, “EPA will need to decide how to apply its regulatory discretion regarding the advanced and total RFS targets as allowed by law.” The U.S. EPA did reduce compliance levels for cellulosic ethanol in 2012 and 2013, setting the 2013 target at 6 million gallons, less than half of the level in February 2013 proposed rulemaking and well below the one billion gallons foreseen in EISA. The final 2013 rulemaking did maintain the advanced biofuel target at statutory levels, with the total renewable fuels target at 16.55 billion gallons. The final rulemaking does project, however, that EPA will need to adjust the total target below the 18.15 billion gallons contained in EISA.²⁸¹ The EIA points out that the expectation that cellulosic and advance biofuels could be available in significant volumes at reasonable costs has not been realized and that the general reduction in fuel volumes consumed places additional pressure on biofuel volumes targets.²⁸²

9.4.2 AFV Purchase and Fueling Infrastructure Support Incentives

The USDA Advanced Biofuel Payment Program: This program, within the USDA’s Rural Development Office, provides payments²⁸³ to biofuel producers to support and expand production of advanced biofuels.²⁸⁴ Under this program, payments are made to eligible producers based on the amount of advanced biofuels produced from renewable biomass, other than corn kernel starch. Biofuel can be made from a variety of non-food sources, including waste products. Examples of eligible feedstocks include, but are not limited to, crop residue, animal, food and yard waste material, vegetable oil, and animal fat. To be eligible, producers must enter into a contract with USDA Rural Development for advanced biofuels production and submit records to

²⁸⁰ NERA Economic Consulting. October 2012. Economic Impacts Resulting from Implementation of RFS2 Program. Accessed August 2013 online at: http://www.epi.org/~media/Files/Policy/Alternatives/13-March-RFS/NERA_EconomicImpactsResultingfromRFS2Implementation.pdf

²⁸¹ U.S. Energy Information Administration. August 14, 2013. EPA Finalizes Renewable Standard for 2013; Additional Adjustments Expected in 2014. Accessed August 2013 online at: <http://www.eia.gov/todayinenergy/detail.cfm?id=12531>

²⁸² Energy Information Administration, U.S. Department of Energy, statement of Adam Sieminski, Administrator, before the Subcommittee on Energy and Power, Committee on Energy and Commerce, U.S. House of Representatives, June 26, 2013, http://www.eia.gov/pressroom/testimonies/sieminski_06262013.pdf

²⁸³ One payment is based on actual production and another payment is based on incremental production.

²⁸⁴ U.S. Department of Agriculture Advanced Biofuel Payment Program. Online at: http://www.rurdev.usda.gov/BCP_Biofuels.html

document their production.²⁸⁵ Through this and other programs, USDA is working to support the research, investment and infrastructure necessary to build a strong biofuels industry that creates jobs and broadens the range of feedstocks used to produce renewable fuel.

California Alternative and Renewable Fuel and Vehicle Technology Program (ARFVT)²⁸⁶: This program provides funding of up to \$100 million annually, leveraging public and private investment to develop and deploy clean, efficient, and low-carbon alternative fuels and technologies.²⁸⁷ California's objective is to produce 20 percent of biofuels used in state by 2010, 40 percent by 2020, and 75 percent by 2050. The CEC developed and adopted three investment plans since 2008 that guide more than \$361 million in total awards for the first four fiscal years of the ARFVT Program, of which \$114.9 million was allocated to biofuels. Using funds from this first investment plan (fiscal years 2008-09 and 2009-10), plus a portion of funds from the second investment plan (fiscal year 2010-2011), the Energy Commission funded 86 projects totaling \$197.4 million to date, of which \$64 million was awarded to biofuels.²⁸⁸ The most recent investment plan, covering fiscal years 2012-2013, allocates \$20 million and \$21.5 million to alternative fuel production and alternative fuel infrastructure, respectively²⁸⁹.

²⁸⁵ U.S. Department of Agriculture Rural Development Energy Programs Fact Sheet. Online at: http://www.rurdev.usda.gov/SupportDocuments/RD_energy_factsheet_1928_2009_final.pdf

²⁸⁶ California Energy Commission. California's Alternative & Renewable Fuel & Vehicle Technology Program. Online at: <http://www.energy.ca.gov/drive/>

²⁸⁷ California Energy Commission. Background Information: 2013-2014 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program. Online at: <http://www.energy.ca.gov/2012-ALT-2/background.html>

²⁸⁸ California Energy Commission. Benefits report for the Alternative and Renewable Fuel and Vehicle Technology Program (December 2011). Online at: <http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf> (page 20)

²⁸⁹ California Energy Commission. 2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program (May 2012). Online at: <http://www.energy.ca.gov/2012publications/CEC-600-2012-001/CEC-600-2012-001-CMF.pdf> (page 4)

10 Shore Power

Table 50: Potential Costs and Benefits and Additional Screening Criteria for Implementation of Shore Power Policies to Washington Consumers and Businesses

Potential Action for Consideration	
<ul style="list-style-type: none"> Implement At-Berth standards in the state of Washington 	
Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
<ul style="list-style-type: none"> No consumer costs from shore power projects have been identified Improved air quality through reduction in emissions 	<ul style="list-style-type: none"> Increased costs for vessel construction or retrofit Increased competitiveness as more global ports equip vessels with shore power capabilities Reduced energy costs while vessels call at port Shore power infrastructure requires investment from ports and companies to design, build, and install shore power technology both on land and vessels. These projects represent opportunities for engineering and construction jobs within the State of Washington Shipping companies will see a reduction in costs associated with reduced fuel consumption Shore power at ports in Washington has the potential to increase the demand on local jurisdictions' electric power supply
Summary of Screening Criteria	
<p><i>Does the policy target an emissions source of significant magnitude in Washington?</i></p> <p>The fuel use and emissions from maritime port sources can be significant, with OGVs and harbor craft being major contributors to air pollution and GHG emissions in and around ports. Emissions from marine vessels contributed approximately 3.1 percent (or 3 MMTCO₂e) of Washington State's annual GHG emissions in 2010. However, only a portion of these emissions occur when vessels are at-berth. For example, the ocean going vessel hotelling and maneuvering at berth generated about 25 percent of the overall marine emissions in the Puget Sound in 2011.²⁹⁰</p> <p><i>What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?</i></p> <p>Port electrification efforts in Washington, California, and several Canadian provinces have yielded positive results in infrastructure investment, achievement of GHG reductions, and economic payback. The volume of reductions, however, are relatively small compared to overall jurisdictional emissions.</p> <p><i>Is the policy discrete and comprehensive, or is it instead a bundle of related policies?</i></p> <p>The policy itself can be discrete and comprehensive, in the form of a program or regulation targeted at reducing emissions from ships at berth, but implementation of the policy requires the integration of</p>	

²⁹⁰ Puget Sound Maritime Air Forum. Puget Sound Maritime Air Emissions Inventory. August 2012. Page 27. Accessed September 2013 online at: http://www.pugetsoundmaritimeairforum.org/uploads/PV_FINAL_POT_2011_PSEI_Report_Update_23_May_13_scg.pdf

various projects and stakeholders, as Shore Power requires extensive infrastructure improvements both on the terminal side, for supplying the appropriate level of conditioned electrical power, and on-board the vessels that will use the system; and participating ports and maritime companies would need to collaborate.

Can the policy be meaningfully implemented or influenced at the State level?

Yes, as shown in the example of California's At-Berth Regulation, the policy can be levied at the state level, and various projects can also obtain funding from state sources.

10.1 Introduction

Washington State seaports operate ferries, container ships, cruise ships and a variety of other ocean going vessels (OGVs). The port system is a major economic hub in the state. For example, the Port of Seattle supported approximately 29,000 direct and indirect jobs, \$2.5 billion of business revenue, and \$457.5 million state and local taxes in 2008.²⁹¹

Shore power, also known as port electrification or cold ironing, is the process of transferring the electrical generation needs for OGVs while at berth (docked) from onboard diesel auxiliary engines to cleaner, shore-side, power grids. Shore power is often intended to help improve air quality at ports, but has the added benefit of reducing GHG emissions from OGVs during port calls.

The fuel use and emissions from maritime port sources can be significant, with OGVs and harbor craft being major contributors to air pollution and GHG emissions in and around ports. Emissions from marine vessels also contributed approximately 3.1 percent (or 3 MMTCO₂e) of Washington State's annual GHG emissions in 2010. Approximately one-third to one-half of emissions attributed to OGVs come from their auxiliary diesel engines, which are run while the vessel is at berth and require electrical power for everything from lighting to loading and discharging equipment. Reducing the use of diesel auxiliary engines while OGVs are at port reduces GHG emissions and improves air quality by reducing emissions of particulate matter (PM) and nitrogen oxides (NO_x).²⁹² The Puget Sound Clean Air Agency (PSCAA) calculates that

²⁹¹ Port of Seattle. 2009. Port of Seattle Economic Impact. Accessed August 2013 at:

http://www.portseattle.org/Supporting-Our-Community/Economic-Development/Documents/EconomicImpact_2009Brochurev2.pdf

²⁹² Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 5. Accessed August 2013 at:

http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf

just eight hours of shore power cuts on-board oil burning by 2.85 metric tons of fuel. For cruise ships, air emissions are reduced by about 30 percent per eight-hour port call.²⁹³

The shore power approach is generally best suited for vessels that make multiple calls at the same terminal for multiple years. The best candidates for shore power are large container ships, cruise ships, refrigerated (reefer) ships, and specially-designed crude tankers that have diesel-electric engines. Shore power requires extensive infrastructure improvements both on the terminal side, for supplying the appropriate level of conditioned electrical power, and on-board the vessels that will use the system.²⁹⁴

California and Canada (primarily British Columbia) have implemented shore power regulation and initiatives, respectively. Washington ports have facilitated private sector infrastructure investments to implement shore power for a cruise terminal at the Port of Seattle and a container ship terminal at the Port of Tacoma. Shore power presents increased competitiveness for ports and businesses as more fleets fit vessels with shore power capabilities,²⁹⁵ and as shore power technology is adopted more broadly at all West Coast ports, shore power will become more feasible for container and cargo ships that call at Washington ports.²⁹⁶ No federal standards or control requirements have been promulgated addressing emission reductions from at-berth OGV auxiliary engines.²⁹⁷

Another related policy that targets emissions near or at ports is known as positive restraint, and provides another opportunity to reduce reliance on vessel engines while docked.

10.2 Literature Review of Washington Potential

The Port of Seattle, Princess Cruises, and Holland America Line completed a \$7.5 million shore power project at Seattle's Terminal 30 in 2005 and 2006. Participating vessels cut annual CO₂

²⁹³ Electrify Transportation in Washington. 2007. Electrify Transportation Briefing Book. (January 2007.) Page 16. Accessed August 2013 at: http://www.plugincenter.net/wp-content/uploads/2010/10/Electrify_Transportation_Briefing_Book.pdf

²⁹⁴ San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: <http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485>

²⁹⁵ San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: <http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485>

²⁹⁶ Electrify Transportation in Washington. 2007. Electrify Transportation Briefing Book. (January 2007.) Page 16. Accessed August 2013 at: http://www.plugincenter.net/wp-content/uploads/2010/10/Electrify_Transportation_Briefing_Book.pdf

²⁹⁷ California Air Resources Board (CARB). Adoption of the Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-going Vessels While at Berth. (October 18, 2008). Accessed August 2013 at: <http://www.arb.ca.gov/regact/2007/shorepwr07/uid2007.pdf>

emissions by up to 29 percent and saw financial savings on energy costs of up to 26 percent per call.²⁹⁸ The cruise lines' shore power systems were relocated to Terminal 91 in 2009.²⁹⁹ In October 2010, the Port of Tacoma and Totem Ocean Trailer Express, Inc. (TOTE) completed a \$2.7 million shore power project. EPA awarded the Port of Tacoma a \$1.5 million grant to construct a shore-side connection and power system at the terminal. TOTE contributed approximately \$1.2 million to retrofit two Alaska trade ships that make weekly calls at the terminal. The shore power project estimated a reduction of diesel and GHG emissions by up to 90 percent during TOTE's 100 annual ship calls. That translates to about 1.9 tons of diesel particulates and 1,360 mtCO_{2e} each year. The infrastructure update sustained an estimated 50 manufacturing and local installation jobs.³⁰⁰ Shore power projects are not expected to impact consumers.

The Port of Seattle and Tacoma, along with Port Metro Vancouver, have implemented the Northwest Ports Clean Air Strategy, beginning in 2007. The ports have implemented a series of mandatory engine and fuel standards, as well as voluntary measures, aimed at reducing emissions from OGVs, cargo-handling equipment, rail, trucks, and harbor vessels. The Air Strategy is intended to improve air quality with the co-benefit of reducing GHG emissions.³⁰¹

Additionally, WSDOT has investigated a positive restraint system that will allow Washington State Ferry (WSF) vessels to be safely secured in dock for loading and unloading operations with reduced engine power to save fuel. The estimated cost of the required marine structures, vacuum restraint equipment and support system is \$4 million per terminal or \$8 million per route. WSF consumes 17.7 million gallons of diesel fuel per year. For example, the two vessels on the Edmond Kingston route consume, on average, 2.7 million gallons per year. Twenty percent of the two vessels' fuel usage (540,000 gallons) is consumed pushing into the dock. By using positive restraint to reduce the power of the engines to support hotel loads only, 270,000 gallons per year can be saved, which equals approximately \$1 million in fuel costs. In addition, 3,000 operating hours per engine can be reduced annually resulting in approximately \$750,000 reduction in engine maintenance costs per year.³⁰²

²⁹⁸ 40 Cities. Port of Seattle Cuts Vessel Emissions by 29% Annually and Saves 26% on Energy Costs per Call. Access August 2013 at: http://www.c40cities.org/c40cities/seattle/city_case_studies/port-of-seattle-cuts-vessel-emissions-by-29-annually-and-saves-26-on-energy-costs-per-call

²⁹⁹ Cochran Marine. Seattle – Terminal 91 Shore Power Relocation. Accessed August 2013 at: <http://www.cochranmarine.com/current-installations/seattle-shore-power-relocation-terminal-91/>

³⁰⁰ Port of Tacoma. First cargo ship in Pacific Northwest plugs into shore power at Port of Tacoma. (October 27, 2010). Accessed August 2013 at: <http://www.portoftacoma.com/Page.aspx?cid=4773>

³⁰¹ Northwest Ports. Northwest Ports Clean Air Strategy, 2012 Implementation Report. (July 8, 2013). Accessed August 2013 at: http://www.portseattle.org/Environmental/Air/Seaport-Air-Quality/Documents/NWPCAS_2012_Progress_Report_20130708.pdf

³⁰² Washington State Department of Transportation. September 10, 2013. Personal communication with Seth Stark. Data taken from the "11-13 Biennium Scoping Proposed Capital Terminal Improvement Biennium Project Submission Form" for the Edmonds and Kingston Terminals.

Additional notable experience from the western U.S. and Canada may inform potential policy actions for Washington. The following examples provide estimates of the types of economic and GHG impacts that might be achievable in Washington. Policies have been implemented with positive results in California and several Canadian provinces.

In December 2007, the California Air Resources Board (ARB) approved the “Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port” Regulation, commonly referred to as the At-Berth Regulation. The purpose of the At-Berth Regulation is to reduce diesel particulate matter (DPM) and nitrogen oxides (NO_x) emissions from diesel auxiliary engines on container ships, passenger ships, and refrigerated-cargo ships while berthing at California Ports. Responding to the At-Berth regulation, the Port of Los Angeles (POLA) and Long Beach (POLB) invested a combined \$52.1 million to implement shore power programs, expecting the use of shore power at berth will reduce OGV emissions of CO₂ by 95 percent per vessel call. The Port of San Francisco became the first California port to provide shore power for cruise ships while at berth in October 2010. The project budget was \$5.2 million, with estimated reductions in emissions for a 10-hour ship call being approximately 140 pounds of DPM, 1.3 tons of NO_x, 0.87 tons of sulfur oxides (SO_x), and 19.7 mtCO₂e.³⁰³

Transport Canada, the country’s department responsible for developing regulations, policies, and services of transportation, completed the Marine Shore Power Program between 2007 and 2012. The Port Metro Vancouver became the first port in Canada and third in the world to install shore power for cruise ships. The 2009 installation represents a \$9 million (CAD) initiative by the Government of Canada, the British Columbia Ministry of Transportation and Infrastructure, Holland America Line, Princess Cruises, BC Hydro and Port Metro Vancouver. Between April and October 2010, Port Metro Vancouver completed 44 shore power connections, which reduced greenhouse gas emissions by 1,521 mtCO₂e. Based on costs at the time of measurement, cruise ships saved an average of \$234 (CAD) and 1.78 metric tons of fuel each hour that their engine was shut off while at berth.³⁰⁴ In 2011, 35 vessels connected to the Ports shore power facilities, reducing GHG emissions by 1,318 mtCO₂e.³⁰⁵

In January 2012, the Government of Canada approved a \$27.2 million (CAD) Shore Power Technology for Ports Program as part of the country’s Clean Air Agenda. As part of the program, Seaspan Ferries Corporation will be installing shore power at the Swartz Bay Ferry

³⁰³ Office of the Mayor, City & County of San Francisco. Mayor Newsom and the Port of San Francisco Inaugurate Cruise Ship Using Shoreside Power. (October 2010). Accessed August 2013 at:

<http://www.epa.gov/region9/mediacenter/posf-dera/SF-Port-Shore-Power.pdf>

³⁰⁴ Transport Canada. Case Study – Port Metro Vancouver Shore Power Project. (February 2, 2012). Accessed August 2013 at: <http://www.tc.gc.ca/eng/programs/environment-sptp-case-study-2690.htm>

³⁰⁵ Port Metro Vancouver. Shore Power at Canada Place. Access August 2013 at: <http://www.portmetrovancouver.com/en/about/cruiseandtourism/shorepower.aspx>

Terminal in 2013. The project will cost \$179,300 (CAD) and will decrease fuel consumption at the Swartz Bay Ferry Terminal by approximately 70,000 litresliters (18,500 gallons) annually, representing a net savings of about \$45,000 (CAD) and an approximate 210 mtCO₂e reduction in GHG emissions.³⁰⁶ Beginning in 2014, the Port of Halifax will be the first port in Atlantic Canada to implement shore power for cruise ships. The shore power infrastructure project represents a \$10 million (CAD) initiative among the Government of Canada, the Province of Nova Scotia, and the Port of Halifax. Once installed, the shore power operation will decrease cruise ship idling by seven percent, which represents an annual decrease of approximately 123,000 litresliters (32,500 gallons) of fuel usage and 370 mtCO₂e and air pollutant emissions.³⁰⁷

³⁰⁶ Transport Canada. Shore power arrives at Swartz Bay Ferry Terminal. (March 6, 2013). Accessed August 2013 at: <http://www.tc.gc.ca/eng/mediaroom/releases-2013-h024e-7068.htm>

³⁰⁷ Transport Canada. Shore power arrives at the Port of Halifax. (January 23, 2013). Accessed August 2013 at: <http://www.tc.gc.ca/eng/mediaroom/releases-2013-h003e-7035.htm>

11 Public Benefit Fund (PBF)

Table 51: Potential Costs and Benefits of a Public Benefit Fund to Washington Consumers and Businesses

Potential Action for Consideration	
<ul style="list-style-type: none"> • Create clean energy business and economic development Public Benefit Fund • Create a Public Benefit Fund to serve electric utilities exempt from I-937 and natural gas utilities • Create a Public Benefit Fund to pursue efficiency that becomes cost-effective only when the price of carbon is included 	
GHGs and Costs in Washington	
Three potential program designs are separately considered and quantified	
Implementation Issues and Lessons Learned	
<ul style="list-style-type: none"> • Cost recovery under I-937 functions similarly to a PBF, but a PBF can result in greater equity across citizens. • Rates must be set such that the PBF generates significant revenues without unduly impacting consumers. • PBF can target renewable energy, energy efficiency, clean energy research, development, and deployment (RD&D), or all of the above. • PBF can be used for low income assistance. 	
Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
<ul style="list-style-type: none"> • Reduce energy costs for consumers by reducing average bills and by limiting future energy price increases. • Electricity and/or natural gas rates will increase on a per kilowatt-hour or per therm basis as a result of the system benefits charge (SBC)³⁰⁸, thus, higher energy consumers will pay more on an annual basis. These increased costs may be offset by the availability of resources for energy efficiency improvements. • Increased access to energy conservation and distributed renewable technology incentives and financing. • Improved grid reliability and emissions rates. 	<ul style="list-style-type: none"> • Reduce energy costs for businesses by reducing average bills and by limiting future energy price increases. • Energy intensive sectors may face higher electric and/or natural gas rates. These increased rates may be offset by the availability of resources for energy efficiency improvements. • Increased access to energy conservation and distributed renewable technology incentives and financing. • Increased access to energy research, development, deployment, and other business development funding. • Increased commercialization of innovative or underutilized technologies to serve as a "feeder" to help achieve I-937 goals. • Improved grid reliability and emissions rates. • Expanded clean energy talent pool and job creation. • Improved cleantech competitiveness.
Summary of Screening Criteria	
<i>Does the policy target an emissions source of significant magnitude in Washington?</i>	

³⁰⁸ A system benefits charge is a small surcharge to all ratepayers on electricity and/or gas consumption that produces revenue to fund the PBF.

Public benefit funds are used to fund utility demand-side management programs. These demand-side emissions sources primarily include electricity and natural gas consumption in the residential, commercial, and industrial sectors. These sources accounted for about 40 percent of State emissions in 2008.³⁰⁹

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

States that use public benefit funds to finance energy efficiency programs have demonstrated a leveled cost of saved energy of between \$16 and \$33 dollars per megawatt-hour saved for electricity conservation measures and between \$0.27 and \$0.55 dollars per therm for natural gas conservation measures.³¹⁰ For electricity, this cost is generally much cheaper than developing new generation sources and results in significant GHG savings. Several states including California and New York also use public benefit funds for research, development, and deployment programs focused on clean energy business and economic development rather than strictly on GHG reductions.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

A public benefit fund is simply a funding mechanism for energy programs. States with existing public benefit funds commonly use the money to fund a variety of energy efficiency, renewable energy, and clean energy research, development, and deployment programs.

Can the policy be meaningfully implemented or influenced at the State level?

Public benefit funds are most commonly implemented at the state level. The allocation of funds to underlying programs is typically administered directly by a state public service commission, or through a third-party administrator or utility service providers with public service commission oversight.

11.1 Introduction

A public benefits fund (PBF) is a policy mechanism intended to provide long-term, stable funding to support a variety energy-related programs that benefit the public at large. Specifically, states use PBFs to fund programs related to energy efficiency, investment in renewable energy, reduction of energy usage, environmental concerns, and provide aid to low-income customers.³¹¹

Through the successful reduction of energy usage, PBFs not only reduce GHG emissions but can save customers millions of dollars in energy costs through financial (for example, rebates, grants, loans and performance-based incentives) and technical efficiency assistance, training programs, education, and investment in renewable energy sources.

³⁰⁹ Department of Ecology. 2010. Washington State Greenhouse Gas Emissions Inventory 2008

<https://fortress.wa.gov/ecy/publications/publications/1002046.pdf>

³¹⁰ ACEEE. 2009. Saving Energy Cost-Effectively: A National Review of the Cost of Saved Energy through Utility-Sector Energy Efficiency Programs. Accessed August 2013 at:

<http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf>

³¹¹ DSIRE. 2013. Public Benefit Funds. Accessed August 2013 at:

<http://www.dsireusa.org/solar/solarpolicyguide/?id=22>

PBF revenues are typically collected from ratepayers through a small surcharge, or system benefits charge (SBC), on electricity and/or gas consumption, or through a flat monthly fee. These charges are typically “non-bypassable,” meaning they are assessed to all customers in a nondiscriminatory fashion since customers are charged a PBF fee without regard to where they purchase electricity or gas. In other words, the charge is assessed for use of the distribution system rather than based upon the source of the electricity or gas.³¹² Alternatively, some PBFs are funded through specified contributions from utilities.³¹³ Recently, some states have begun to supplement PBFs using alternative compliance payments made by utilities under state renewable portfolio standard (RPS) programs, or the revenue from the sale of carbon emissions allowances in the Regional Greenhouse Gas Initiative (RGGI) auctions.³¹⁴

Despite the general benefits, some utilities and large energy consumers have individual concerns about PBFs. Utility companies with coupled profits and sales may be opposed to a PBF because the energy efficiency and renewable energy programs funded by a PBF may reduce sales, revenue, and profit. In addition, sales may be further reduced if the additional PBF charge increases energy prices enough to warrant energy conservation measures to reduce energy expenditures. By contrast, utilities that have capacity constraints that force them to utilize high-cost peaking power to meet electricity demand generally accept energy efficiency and load management programs funded by PBFs as a means of controlling peak load. In several states, utilities also benefit from PBFs that support their efforts to meet renewable portfolio standards. The unique supply and demand characteristics of affected utilities must be considered carefully in developing a PBF that supports energy efficiency, renewable energy, and other programs without adversely affecting utility profit margins.³¹⁵

Large energy consumers may also oppose a PBF policy due to concerns about added energy costs. Despite these concerns, large energy consumers may receive a large benefit from PBF energy efficiency programs that provide significant energy and cost savings. In addition, PBF programs have the potential to reduce electricity supply constraints, produce lower rates for customers, and increase system reliability through lower peak energy demands. Ultimately, policymakers and program administrators must decide how best to allocate PBF funds to maximize public benefits and appease all stakeholders.³¹⁶

³¹² DOE. 2010. Public Benefit Funds: Increasing Renewable Energy & Industrial Energy Efficiency Opportunities. Accessed August 2013 at: <http://www1.eere.energy.gov/manufacturing/states/pdfs/publicbenefitfunds.pdf>

³¹³ Center for Climate and Energy Solutions, 2013. Public Benefit Funds. Accessed August 2013 at: <http://www.c2es.org/sites/default/modules/usmap/pdf.php?file=5893>

³¹⁴ DSIRE. 2013. Public Benefit Funds. Accessed August 2013 at: <http://www.dsireusa.org/solar/solarpolicyguide/?id=22>

³¹⁵ DOE. 2010. Public Benefit Funds: Increasing Renewable Energy & Industrial Energy Efficiency Opportunities. Accessed August 2013 at: <http://www1.eere.energy.gov/manufacturing/states/pdfs/publicbenefitfunds.pdf>

³¹⁶ Ibid

A summary of existing PBF policies with significant clean energy business development appropriations is provided in Section 11.4, with a review of additional PBF programs provided in Appendix B. Section 11.2 summarizes existing work that has been done to evaluate the potential for, and impacts of, a PBF in Washington. Section 11.3 presents original analysis conducted for this report, which evaluates the potential emission reductions from three sample PBF-funded activities in Washington.

11.2 Literature Review of Washington Potential

Washington's Energy Independence Act (Initiative 937) requires utilities to meet energy efficiency and renewable energy targets. The energy conservation section of I-937 requires each electric utility with more than 25,000 customers to "pursue all available conservation that is cost-effective, reliable and feasible."³¹⁷ The renewable energy targets require each utility to obtain at least 15 percent of their electricity from new renewable resources by 2020. I-937 allows each qualifying investor-owned utilities to "recover all prudently incurred costs associated with compliance."³¹⁸ Cost recovery is achieved through rate adjustments and the charge is stated as a discrete line item on customer bills. This makes cost recovery under I-937 essentially similar to a SBC used in other jurisdictions, however, cost recovery and conservation efforts can be more broadly distributed with a PBF. Under I-937, each utility recovers its own costs from its own customers and the economic burden can vary across customers since some utilities may pursue conservation more or less vigorously than others. A PBF, by contrast, can result in greater equity across citizens and a higher overall level of effort with respect to acquisition of efficiency and renewable energy resources.

If Washington were to implement a PBF to supplement I-937, PBF dollars would need to be invested carefully to avoid redundancy with I-937 programs. For electricity conservation, this would mean that it could be used for conservation that does not meet the I-937 standard for cost-effectiveness, but which may still be relatively low cost as a GHG mitigation strategy. Any PBF dollars invested in renewable generation for qualifying utilities would either be used to contribute to the targets of I-937, or invested separately in renewable energy projects that do not contribute to RPS requirements. Similarly, the costs associated with natural gas conservation efforts by the State's regulated gas utilities, though not mandated by I-937, are also already recovered through rate adjustments or utility-level SBCs.³¹⁹

³¹⁷ RCW 19.285.040 - Energy conservation and renewable energy targets. Accessed August 2013 at: <http://apps.leg.wa.gov/rcw/default.aspx?cite=19.285.040>

³¹⁸ RCW 19.285.050 - Resource costs. Accessed August 2013 at: <http://apps.leg.wa.gov/rcw/default.aspx?cite=19.285.050>

³¹⁹ Utilities and Transportation Commission Website. Accessed August 2013 at: <http://www.utc.wa.gov/consumers/energy/Pages/companyConservationPrograms.aspx>

In effect, Washington's existing portfolio of ratepayer-funded energy efficiency and renewable energy programs are functionally similar to programs funded by PBFs in other states. To maximize the usefulness of a potential PBF in Washington, funds therefore must be directed to specific activities that do not interfere or overlap with I-937 or existing natural gas conservation initiatives. The following potential opportunities have been identified which may benefit from PBF support³²⁰:

- Clean energy business and economic development
- Energy efficiency and renewable development support for natural gas utilities and electric utilities not covered by I-937
- Climate change driven energy conservation through consideration for the cost of carbon

These potential opportunities are not meant to be an exhaustive list of initiatives that could be financed through a PBF. Washington could utilize PBF dollars to fund any combination of these initiatives or entirely different programs.

11.2.1 Clean Energy Business and Economic Development

Several states including California and New York, utilize PBF policies to fund energy research, development and deployment programs as well as general clean energy business and economic development initiatives. In 2010, a similar program was recommended for Washington by the Washington Clean Energy Leadership Council (CELC), with support from Navigant Consulting Incorporated, in their *Clean Energy Leadership Plan*. The Leadership Plan recommended a framework for growing clean energy businesses and jobs in Washington by promoting deployment and commercialization of cutting-edge clean energy solutions in the State as a platform for exporting clean energy solutions. The Leadership Plan also suggested a PBF, with a minimum funding level of \$20 million, plus one to two times match funding from federal and private sources, as a promising funding source to support the initiative.³²¹ With total retail electricity sales of approximately 93,700 gigawatt-hours in 2011³²², an average SBC of about \$0.00022 per kilowatt-hour would be required to generate \$20 million in Washington. Assuming \$40 to \$60 million in total annual investment, the Plan projects the creation of 25,000 direct clean energy jobs and an additional 25,000 indirect and induced jobs by 2020 compared to business-as-usual if the program were to have begun in 2012. In total, the 50,000 new jobs could

³²⁰ Other activities identified which may warrant further investigation include support for (1) fuel oil and propane efficiency activities and (2) utilities limited by the cost cap in their efforts to meet I-937 renewable generation targets.

³²¹ Navigant Consulting Inc. 2010. Washington State Clean Energy Leadership Plan Report. Accessed August 2013 at:

http://wacleanetech.org/wp-content/uploads/2011/08/CELC_Navigant-Final-Report_Final.pdf

³²² EIA State Energy Data System. Accessed August 2013 at: <http://www.eia.gov/electricity/data.cfm#sales>

earn nearly \$2.5 billion in annual income (in 2010 dollars).³²³ The study does not estimate the GHG impacts resulting from actions defined in the Leadership Plan since the primary drivers are job creation and economic development.

Subsequent to the Leadership Plan Report, the CELC presented a series of specific recommendations for implementing the Leadership Plan in a letter to Governor Gregoire and the Legislature in January 2011.³²⁴ The first recommendation in the letter was to establish an “innovative, dynamic Clean Energy Partnership by consolidating and refocusing existing state resources, rather than creating a new organization.” As a result, the 2011 Legislature introduced, but did not pass, a bill that would have formally created the Washington Clean Energy Partnership (CEP) and established a funding mechanism. Instead, the 2011 legislature established a more broadly defined new state agency called “Innovate Washington” described by RCW 43.333 as “a collaborative effort between the state's public and private institutions of higher education, private industry, and government and is to be the primary agency focused on growing the innovation-based economic sectors of the state and responding to the technology transfer needs of existing businesses in the state.” Innovative Washington’s mission was to “make Washington the best place to develop, build, and deploy innovative products, services, and solutions to serve the world.”³²⁵ In July, the 2013 Legislature eliminated funding for Innovate Washington after two years of operation.³²⁶

11.2.2 Energy Efficiency and Renewable Development Support for Natural Gas Utilities and Electric Utilities Not Covered by I-937

Initiative 937 requires each electric utility with more than 25,000 customers to meet energy conservation and renewable generation targets. Seventeen of the State's 62 utilities are currently required to meet I-937 targets and provide approximately 81 percent of the electricity in Washington.³²⁷ This means that utilities responsible for providing the remaining 19 percent of electricity in Washington are not subject to I-937 requirements. Likewise, natural gas utilities are

³²³ Navigant Consulting Inc. 2010. Washington State Clean Energy Leadership Plan Report. Accessed August 2013 at:

http://wacleanetech.org/wp-content/uploads/2011/08/CELC_Navigant-Final-Report_Final.pdf

³²⁴ Washington Clean Energy Leadership Council. 2011. Letter to the Governor and Legislator. Accessed August 2013 at: http://wacleanetech.org/wp-content/uploads/2011/08/CELC-Recommendations--Transmittal-Letter_Final.pdf

³²⁵ GreenTech. 2012. The State of Cleantech in Washington, Part I: Clean Energy Leadership. Accessed August 2013 at: <http://www.wagreentech.com/2012/02/state-of-cleantech-in-washington-part-i/>

³²⁶ Sowa. 2013. Innovate Washington loses state funding. Accessed August 2013 at:

<http://www.spokesman.com/stories/2013/jul/11/innovate-washington-loses-state-funding/>

³²⁷ Department of Commerce EIA Reporting Website. Accessed August 2013 at:

<http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx>

also not covered by I-937³²⁸. A PBF could be used to finance energy conservation and renewable energy development for the customers of Washington's natural gas and small electric utilities.

Maximizing GHG reductions from this type of PBF-funded program would require careful examination of the incremental effect of investments in electricity efficiency compared to natural gas efficiency. A comparison of incremental effects in the natural gas sector versus the electric sector may include examination of the following sector characteristics:

- The strength of existing mandates for energy efficiency for natural gas utilities relative to electric utilities,
- The strength of market incentives due to the retail per-Btu price of natural gas relative to electricity, and
- The carbon intensity of natural gas relative to electricity (e.g., if natural gas is the incremental resource in the electricity resource stack the direct use of natural gas may actually produce less carbon than the use of electricity to serve the same demand)

The above list is not exhaustive of all sector characteristics that should be examined when optimizing PBF distributions for GHG reductions. Examination of these and other relevant sector characteristics is beyond the scope of this analysis but warrants further investigation.

11.2.3 Climate Change-Driven Energy Conservation through Consideration for the Cost of Carbon

According to the *Sixth Power Plan Midterm Assessment Report*, the lowest cost new generating resource for an energy-short utility is usually a combined-cycle natural gas-fired combustion turbine (natural gas CCCT). The levelized cost of natural gas CCCT is highly dependent on the price of natural gas and is estimated to be about \$50, \$65, and \$80 per megawatt-hour for a plant operating with an average capacity factor of 51 percent and natural gas prices of \$2, \$4, and \$6 per million Btu, respectively³²⁹. Utilities have little incentive to invest in any energy conservation measures that have higher costs on a per megawatt-hour basis, especially utilities with coupled sales and profits. In addition, the I-937 would presumably not permit a utility to count conservation against its targets if it cost more than the cost of electricity from a new natural gas generation resource. With consideration for the cost of carbon, however, the economics change. The U.S. EPA's most recent estimate of the social cost of carbon for 2015 through 2050 is provided below in 2013 dollars.

³²⁸ Suppliers of heating oil and propane are also not covered by I-937 and PBF dollars could be used to support their efficiency projects for their customers, however, the potential GHG reductions from these fuels are limited due to low consumption in the State relative to electricity and natural gas

³²⁹ Northwest Power and Conservation Council. 2013. *Sixth Power Plan Midterm Assessment Report*. Accessed August 2013 at: <http://www.nwcouncil.org/media/6391355/2013-01.pdf>

Table 52. Social Cost of CO₂ and impact on cost of natural gas generation, 2015-2050 (3 percent discount rate)

Year	Social Cost of Carbon (2013\$/metric ton CO ₂) ³³⁰	Calculated Increase to Levelized Cost of Electricity for Natural Gas CCCT (2013\$/MWh)
2020	\$48	\$21
2035	\$63	\$28
2050	\$79	\$35

Table Note: The SCC values are dollar-year and emissions-year specific.

The social cost of carbon is an estimate of the economic damages including but not limited to changes in net agricultural productivity, human health, and property damages from increased flood risk associated with a small increase in carbon dioxide emissions, conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e. the benefit of a carbon dioxide reduction). Based on the emissions of a natural gas CCCT (980 pounds CO₂e per MWh), this equates to an increase in the levelized cost of natural gas CCCT by \$21, \$28, and \$35 per megawatt-hour in 2020, 2035, and 2050, respectively (in 2013 dollars).

The increase in the levelized cost of natural gas CCCT due to consideration for the social cost of carbon would make a greater number of energy conservation measures "cost-effective" and would result in avoided emissions at a rate of 980 pounds or 0.44 metric tons of carbon dioxide per megawatt-hour saved. In the absence of a legislated price on carbon, Washington could use a PBF to finance energy conservation measures that are not considered cost-effective in the traditional sense when compared to the levelized cost of natural gas CCCT, but are cost-effective when consideration is given to the social cost of carbon.

11.3 Quantification

This section analyzes the potential GHG emission reductions that could be generated from implementation of a PBF in Washington. The work includes new analysis and builds on previous analysis, including the consultant work performed in 2010, and Task 1 analysis of the GHG impacts of I-937. Since a PBF is simply a funding mechanism, the GHG impacts are fully dependent on the specific initiatives funded by the PBF and the size of the fund. These analyses investigate GHG impacts for only a sample of potential programs that could be funded through a PBF and the results should only be used for high-level policy evaluation. Where possible, these analyses project to 2020, 2035, and 2050 to provide a picture of the long-term outcomes that

³³⁰ U.S. EPA Website: The Social Cost of Carbon (adjusted from 2011 to 2013 dollars). Accessed August 2013 at: <http://www.epa.gov/climatechange/EPAactivities/economics/scc.html>

could be expected from a sample of PBF-funded programs. In particular, these analyses include estimates of the GHG impacts from PBF dollars appropriated for clean energy business and economic development, energy efficiency and renewable development support for utilities not covered by I-937, and climate change driven energy conservation through consideration for the cost of carbon.

11.3.1 Methodology

Separate analyses that utilized different methodologies were performed for three potential PBF-funded programs. Each unique methodology is described in the sections below.

11.3.1.1 Clean Energy Business and Economic Development

Although GHG reductions are not cited as a primary driver for the clean energy business and economic development program defined in the Clean Energy Leadership Plan, reductions are likely to occur as a result of advancement and accelerated commercialization of clean energy technologies, improvement of energy codes and appliance efficiency standards, and related activities. This type of program essentially acts as a “feeder” of technologies, innovations, and information that can be leveraged to meet I-937 energy conservation and renewable generation requirements and to improve the energy code and appliance efficiency standards. This is an important point when estimating GHG emissions and reductions in the State since the majority of reductions from this type of program are indirect and ultimately subsumed by downstream, beneficiary programs.

The investment options to support clean energy business and economic development are virtually limitless and any forecast of rate of technology development carries extremely high uncertainty. For this analysis, energy savings claims and investment levels of a similarly defined program in New York have been scaled to Washington. The assumptions and methodologies used by New York in their estimates are not available. Therefore, rather than recreate those calculations with assumptions suitable for Washington, this analysis scales the energy savings claims made by New York according to their established investment level compared to an assumed investment level in Washington, and then applies Washington-specific emission factors to estimate GHG reductions. It should be noted that the majority of savings claimed by New York are the result of improvements to the energy code and standards which are informed by the state’s PBF-funded Technology and Market Development (T&MD) program. Since Washington has already implemented an aggressive energy code improvement schedule, a PBF-funded clean energy business and economic development program will undoubtedly inform future energy codes but the associated savings are significantly overlapping between the two programs.

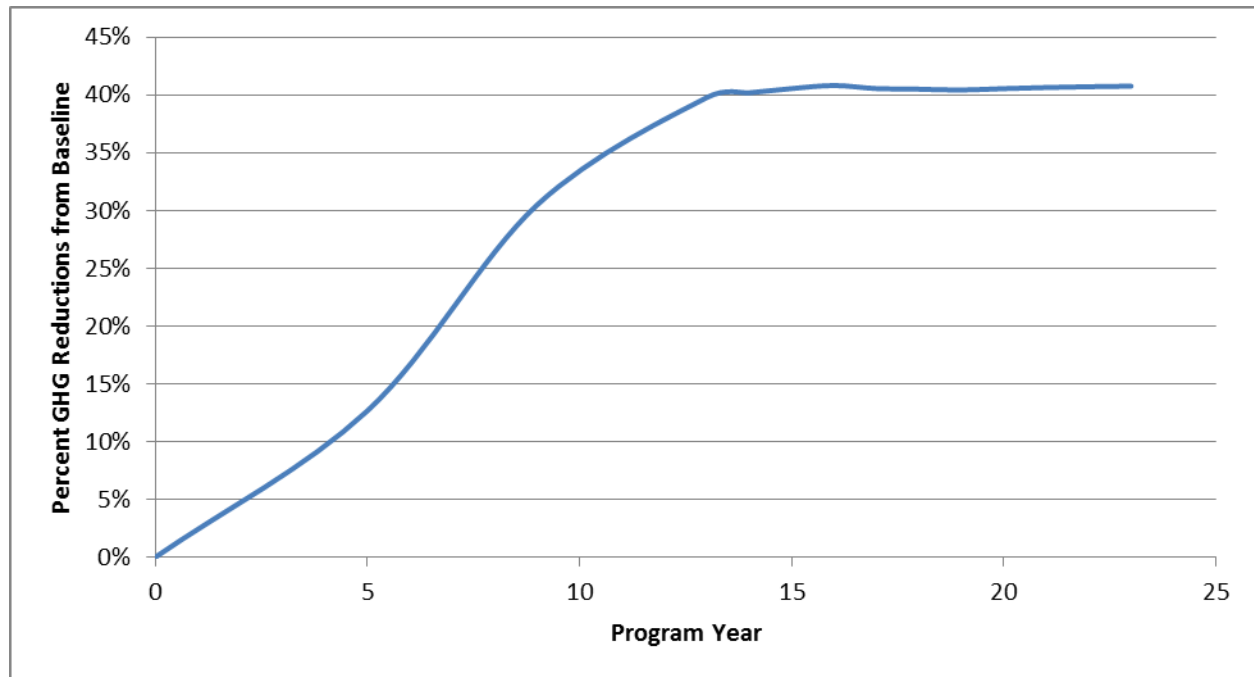
The *NYSERDA Technology and Market Development Program: Semi-Annual Report Through December 31, 2012* projects cumulative annual savings of electricity and natural gas consumption, electricity demand, and carbon dioxide emissions in 2016 and 2020 as a result of program activities and investments made during 2012 through 2016³³¹. The report also estimates that 1.2 times match funding will be leveraged through program investments by 2016. This assumption aligns with that made by Navigant in Washington's *Clean Energy Leadership Plan*. Since the annual budget for NYSERDA T&MD program is approximately \$105 million including 14 percent administrative, evaluation, and other operational costs, and the recommended program funding level in Washington is \$20 million, all energy savings figures presented by NYSERDA are scaled-down by a factor of 20 to 105 (about 19 percent). Projected Washington emissions savings are calculated separately due to differences in regional grid emission factors between Washington and New York.

11.3.1.2 Energy Efficiency and Renewable Development Support for Utilities Not Covered By I-937

The method used to estimate the GHG impacts of achieving I-937 requirements at utilities with less than 25,000 customers included mimicking the pace of GHG reductions on a percentage basis as determined in the Task 1 analysis of I-937 for qualifying utilities and offsetting the start date of the program from 2007 to 2016. This strategy ensures that assumptions are consistent across tasks, and accounts for effects of the later program start date. Since I-937 and the associated draft Task 1 analysis cover utilities responsible for providing about 81 percent of electricity in Washington, this analysis covers the remaining utilities responsible for providing about 19 percent of electricity in the State. As a result, this analysis forecasts baseline scenario emissions for non-qualifying utilities by multiplying the baseline scenario emissions forecast for qualifying utilities (as calculated in the analysis of I-937 under Task 1) by a factor of 19/81, or about 0.24. This analysis also assumes the pace of GHG reductions relative to the baseline scenario will mimic the pace of GHG reductions calculated in the draft Task 1 analysis for qualifying utilities. The pace of GHG reductions as calculated in the draft Task 1 analysis is presented in the table below on a percentage basis.

³³¹ NYSERDA. 2013. Operating Plan for Technology and Market Development Programs (2012–2016). Accessed August 2013 at: http://www.nyserdera.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserdera_tmd_semiannual_report.pdf

Figure 9. Percent GHG Reduction from Baseline for Qualifying Utilities Under I-937 (Draft Task 1 Analysis Results)



Shifting the program start year for small utilities to 2016 results in the following pace of emissions reductions:

Table 53. Pace of Emissions Reductions Relative to Baseline for Achieving I-937 Targets at Utilities with Less than 25,000 Customers Assuming a Program Start Year of 2016

Calendar Year	Program Year	Percent GHG Reduction
2020	5	13%
2035	20	40%

11.3.1.3 Climate Change Driven Energy Conservation through Consideration for the Cost of Carbon

This analysis does not attempt to estimate the supply of available electricity conservation measures that become cost-effective relative to building new generation sources in each target year when the cost of carbon is considered. Instead, this analysis estimates the increase in levelized cost of developing natural gas CCCT generation in each target year as a result of the cost of carbon. Cost increase was determined by multiplying the emission rate for natural gas CCCT technology by the average social cost of carbon in each target year as defined by the EPA for a discount rate of three percent. Ultimately, this cost increase makes a number of energy

conservation measures cost-effective relative to developing new natural gas CCCT generation. In the absence of a carbon cost, these measures were not considered cost-effective.

Since natural gas CCCT generates emissions and energy conservation measures do not, there are GHG savings associated with electing to develop energy conservation measures in lieu of developing new natural gas CCCT generation to accommodate the same demand. These GHG savings are simply represented by the emission rate of natural gas CCCT, defined as 980 pounds per megawatt-hour of generation.³³² This analysis does not attempt to quantify a likely amount of conservation acquired based on PBF size or the supply of available conservation measures. Instead, this analysis provides a scalable cost per metric ton of saved carbon dioxide. Results are provided in the Quantification section below.

11.3.2 Assumptions, Exclusions, and Data Sources

Separate analyses that utilized different assumptions, exclusions and data sources were performed for three potential PBF-funded programs. Each unique set of assumptions, exclusions and data sources is described in the sections below.

11.3.2.1 Clean energy business and economic development

The following assumptions about a clean energy business development program funded through a PBF policy are included in this analysis:

- The program begins in 2016
- Annual state funding through a PBF is \$20 million from 2016 through 2020
- Administration, evaluation, and other operational costs represent 14 percent of total program costs
- Match funding achieves 1.2 times total investments and disbursements by 2020 (i.e., after five program years)
- Electricity and natural gas savings achievement are 19 percent of NYSERDA claims; This ratio was selected to match the program budget ratio
- Electricity emission factors assumed to continuously improve from 2009 to 2050 according the rate projected for the NWPP by AEO2013

This analysis relies on the data sources summarized in Table 32 below.

³³² Department of Commerce. 2012. Survey of Combined Cycle Combustion Turbine Greenhouse Gas Emission Rates. Accessed 2013 at: http://www.leg.wa.gov/documents/legislature/ReportsToTheLegislature/Survey%20of%20Commercially%20Available%20Turbines_FINAL_11%205%2012%20pdf_a776d3a6-d603-42ad-b998-19bbf1c98a31.pdf

Table 54: Primary data sources used to quantify GHG impacts of a Washington State PBF-funded clean energy business and economic development program

Data	Source
NYSERDA T&MD program electricity and natural gas savings projections, total and annual investment levels, and anticipated match funding	NYSERDA. 2013. NYSERDA Technology and Market Development Program: Semi-Annual Report Through December 31, 2012 http://www.nyserdera.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserdera_tm_d_semiannual_report.pdf
Recommended annual investment level for Washington State	Navigant Consulting Inc. 2010. Washington State Clean Energy Leadership Plan Report http://wacleanetech.org/wp-content/uploads/2011/08/CELC_Navigant-Final-Report_Final.pdf
Electricity CO ₂ e emission factor for Northwest Power Pool	EPA. 2012. eGRID2012 year 2009 Summary Tables http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_SummaryTables.pdf
Electricity emission factor improvement rate	EIA. 2013. Annual Energy Outlook 2013. Electric Power Projections for Northwest Power Pool Area http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013&subject=0-AEO2013&table=62-AEO2013&region=3-21&cases=ref2013-d102312a
Natural gas CO ₂ , CH ₄ , and N ₂ O emission factors	The Climate Registry. 2013. The Climate Registry's 2013 Default Emission Factors (http://www.theclimateregistry.org/downloads/2013/01/2013-Climate-Registry-Default-Emissions-Factors.pdf)
Global Warming Potential for CO ₂ , CH ₄ , and N ₂ O	IPCC. 1995. IPCC Second Assessment Report: Climate Change 1995 (SAR) (https://docs.google.com/uc?export=download&confirm=no_antivirus&id=0B1gFp6Ioo3aka3NsaFQ3YIE3XzA)

11.3.2.2 Energy efficiency and renewable development support for utilities not covered by I-937

The following assumptions about a small utility energy efficiency and renewable development program funded through a PBF policy are included in this analysis:

- The program begins in 2016
- Projected baseline GHG emissions at small utilities are proportional to baseline GHG emissions estimated for utilities covered by I-937 in all program years according to the relative share of electricity currently provided by the utilities (i.e., 19% for small utilities and 81% of I-937-covered utilities)
- The pace of GHG reductions relative to the baseline scenario over time and on a percentage basis matches the pace of GHG reductions calculated and forecasted in the draft Task 1 analysis for qualifying utilities under I-937

This analysis relies on the data sources summarized in Table 55 below.

Table 55: Primary data sources used to quantify GHG impacts of a Washington State PBF-funded energy efficiency and renewable development program for small utilities

Data	Source
Baseline emissions forecast and pace of reductions on a percentage basis	Task 1 analysis of the GHG impacts of I-937

11.3.2.3 Climate change driven energy conservation through consideration for the cost of carbon

The following assumptions about a climate change-driven energy conservation program funded through a PBF policy are included in this analysis:

- The program begins in 2016
- Avoided GHGs are the result of reducing demand through energy conservation in lieu of meeting demand with new generation from natural gas CCCT technology
- The emission rate for natural gas CCCT technology is 980 pounds or 0.44 metric tons of carbon dioxide per megawatt-hour
- The average social cost of carbon is \$48, \$63, and \$79 per metric ton of carbon dioxide at a discount rate of three percent for 2020, 2035, and 2050, respectively (in 2013 dollars)

This analysis relies on the data sources summarized the Table 56 below.

Table 56: Primary data sources used to quantify GHG impacts of a Washington State PBF-funded climate change-driven energy conservation program

Data	Source
Natural Gas CCCT Emission Rate	Department of Commerce. 2012. Survey of Combined Cycle Combustion Turbine Greenhouse Gas Emission Rates. Accessed 2013 at: http://www.leg.wa.gov/documents/legislature/ReportsToTheLegislature/Survey%20of%20Commercially%20Available%20Turbines_FINAL_11%205%2012%20pdf_a776d3a6-d603-42ad-b998-19bbf1c98a31.pdf
Social Cost of Carbon in 2020, 2035, and 2050 (adjusted from 2011 to 2013 dollars)	U.S. EPA Website: The Social Cost of Carbon (adjusted from 2011 to 2013 dollars). Accessed August 2013 at: http://www.epa.gov/climatechange/EPAactivities/economics/scc.html
Consumer Price Index (CPI) for 2011 and 2013	U.S. Department Of Labor - Bureau of Labor Statistics ftp://ftp.bls.gov/pub/special.requests/cpi/cpiiai.txt

11.3.3 Results

The sections below present the individual results for all three potential PBF-funded programs presented above. These results are based on several general assumptions and in some cases limited data and are intended to be used only for high-level policy evaluation.

11.3.3.1 Clean energy business and economic development

As noted above, direct GHG reductions are not a primary driver for this type of program, and direct reductions are likely to be dwarfed by indirect reductions that occur as a result of technologies, innovations, and information leveraged to meet I-937 energy conservation and renewable generation requirements, and to improve the energy code and appliance efficiency standards. This is an important point when considering the results presented below since the majority of reductions from this type of program are overlapping with downstream, beneficiary programs.

Based on the anticipated benefits of the NYSERDA T&MD program, and adjusted for the anticipated Washington investment level, the expected direct and indirect benefits in Washington are estimated in Table 57.

Table 57. Hypothetical Washington Clean Energy Business and Economic Development Program Estimated Direct and Indirect Benefits through Five Program Years

Budget and Benefits	Units	Quantity
Total Budget 2016-2020	\$	100 million
Program Investments and Disbursements	\$	86 million
Administrative and Operational Costs	\$	14 million
Match Funding Acquired 2016-2020	\$	106 million
Total Electricity Savings*	MWh	110 thousand
Total NG Savings*	MMBtu	570 thousand
Total Demand Savings*	MW	30
Total System-wide CO₂ Reduction*	Metric Tons	70,000

* Benefits are cumulative annual savings in 2020 (i.e., after 5 program years)

NYSERDA also presents isolated direct savings from projects and technology installations directly funded by the program. If scaled to Washington's assumed program budget, the estimated direct savings in Washington are approximated in Table 58.

Table 58. Hypothetical Washington Clean Energy Business and Economic Development Program Estimated Benefits for Directly Funded Projects and Technology Installations through Five Program Years

Direct Impacts	Units	Quantity
Electricity Savings*	MWh	40,000
NG Savings*	MMBtu	120,000
Demand Savings*	MW	10
System-wide CO ₂ Reduction*	Metric Tons	20,000

* Benefits are cumulative annual savings in 2020 (i.e., after 5 program years)

It is clear from these results that the direct and total program impacts on GHGs is marginal compared to total state emissions. This is to be expected since the primary drivers for this type of

program are job creation and business and economic development rather than GHG reductions. For this reason, cost per metric ton of carbon dioxide reduced is not a relevant metric for this funding option and, thus, is not quantified in this analysis.

11.3.3.2 Energy efficiency and renewable development support for utilities not covered by I-937

Task 1 analysis of qualifying utilities under I-937 indicates that GHG emissions will be reduced by about 10 percent in the fifth program year and just over 40 percent in the fifteenth program year. If utilities with less than 25,000 customers meet the targets defined by I-937 beginning in 2016 for their share of generation in Washington, the following GHG reductions may be achieved.

Table 59. Emissions Reductions Relative to Baseline for Achieving I-937 Targets at Utilities with Less than 25,000 Customers Assuming a Program Start Year of 2016

Calendar Year	Program Year	Projected Baseline Scenario GHGs (MMTCO ₂)	Percent GHG Reduction Relative to Baseline	GHG Reduction (MMTCO ₂)
2020	5	4.5	13%	0.6
2035	20	7.1	41%	2.9

Compiled total cost of compliance data was not available for Washington utilities required to meet the conservation and renewable energy targets defined by I-937. However, a study of utility energy efficiency programs in other states indicates that these programs typically achieve a levelized cost of saved electricity of \$16-33 per megawatt-hour and a levelized cost of saved natural gas of \$0.27-55 per therm.³³³ These costs represent utility costs only and do not include participant expenditures on program-sponsored projects. For renewable energy, the Annual Energy Outlook indicates levelized costs in the range of \$87-144 per megawatt-hour for popular renewable technologies such as wind, solar PV and biomass.³³⁴ Additional analysis is warranted to determine the SBC required to the I-937 targets based on these levelized costs.

Data was not available to estimate Washington-specific emissions abatement costs associated utility energy efficiency and renewable energy programs. Literature suggests abatement costs in other jurisdictions of ranging from a cost of \$51 to a savings of \$103 per metric ton of carbon

³³³ ACEEE. 2009. Saving Energy Cost-Effectively: A National Review of the Cost of Saved Energy through Utility-Sector Energy Efficiency Programs. Accessed August 2013 at:

<http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf>

³³⁴ Energy Information Administration. 2013. Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013. Accessed September 2013 at:

http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

dioxide for energy efficiency programs, and abatement costs ranging from a cost of \$146 to a savings of \$15 per metric ton of carbon dioxide for renewable energy programs. The table below provides abatement costs for more specific types of energy efficiency and renewable energy programs.

Table 60. Cost-effectiveness Comparison of Emissions Reduction Measures (Parentheses Indicate Negative Numbers that Should be Interpreted as Cost Savings)

Policy Category	Emissions Reduction Measure	Emissions Abatement Cost (2010\$/mtCO ₂ e)
Energy Conservation (funded by PBF or PACE)	Financial Incentives and Instruments/ Demand Side Management Programs	(\$43) ^d
	Improvements to Existing Buildings with Emphasis on Building Operations	(\$80) ^e to \$7b
	Lighting	(\$97) ^b to \$51c
	Electronic Equipment	(\$103) ^b
	HVAC Equipment	\$5c to \$50b
	Building Shell	(\$47) ^b to \$21c
	Residential Water Heaters	\$9b
	Conversion Efficiency	(\$17) ^b
Renewable Energy Generation (funded by PBF or PACE)	Distributed Renewable Energy Incentives	\$146 ^a
	Wind	\$22 ^b to \$114 ^e
	Solar Photovoltaic	\$32 ^b to \$51 ^c
	Solar Thermal	\$134 ^e to \$142 ^c
	Geothermal	(\$15) ^c to \$102 ^e
	Small Hydropower	\$100 ^e
	CHP	(\$40) ^b to \$20 ^e

^a = Washington CAT (Washington)

^b = McKinsey MACC (United States)

^c = Bloomberg MACC (United States)

^d = Johns Hopkins MACC (United States)

^e = Sweeney and Weyant MACC (California)

11.3.3.3 Climate change driven energy conservation through consideration for the cost of carbon

Consideration for the social cost of carbon increases the levelized cost of energy for natural gas CCCT by \$21, \$28, and \$35 per megawatt-hour in 2020, 2030, and 2050, respectively. In addition, at a savings rate of 0.44 metric tons carbon dioxide per megawatt-hour (the GHG emission rate of natural gas CCCT technology), Washington could avoid about 440,000 metric tons of carbon dioxide per year for every one million megawatt-hours of demand met through energy conservation measures in lieu of developing new natural gas CCCT generation.

By definition, the social cost of carbon represents the emissions abatement cost under this program option. These abatement costs are \$48, \$63, and \$79 per metric ton of carbon dioxide for 2020, 2035, and 2050, respectively.

11.4 Implementation History

This section summarizes public benefits funds that support clean energy business development implemented in other jurisdictions. It is intended to provide context for the above analysis, and an indication of the relative success of PBFs in other jurisdictions.

California: California created a PBF in 1998 to fund renewable energy, energy efficiency, and research, development and demonstration (RD&D) projects. Originally, the PBF collected a public goods charge (PGC) only on ratepayer electricity use, but a gas surcharge was added in 2001. The California Public Utilities Commission (CPUC) separately collects funds for the California Solar Initiative (CSI), the Self-Generation Incentive Program, the Renewables Portfolio Standard and other programs, but they are not captured in this analysis. In 2011, the state failed to pass legislation authorizing PGC collections in 2012 or later years. However, the Electric Program Investment Charge (EPIC) fund was created to collect funds to continue support for renewable energy and RD&D projects. In addition, a portion of the Procurement Energy Efficiency Balancing Account (PEEBA) was used to continue support for EE and low-income assistance programs on an interim basis. Further CPUC action is needed to continue funding of these programs.³³⁵

The California PGC/EPIC surcharge is non-bypassable, and the CPUC oversees the fund. Generally, the California Energy Commission (CEC) administers the renewable energy and RD&D programs, while utilities administer the energy efficiency and low-income assistance programs. California's surcharges on ratepayer electricity use average \$0.0054/kWh for energy efficiency, \$0.0016/kWh for renewable energy, and \$0.0015/kWh for RD&D. From inception through about 2011, the PGC fund distributed approximately \$228 and \$62.5 million annually for energy efficiency and RD&D, respectively. Renewables received \$135 million annually from 2002 to 2007 and \$65.5 million annually from 2008 to 2011. Beginning 2005, natural gas subaccount baseline funding was \$12 million with increases of up to \$3 million annually to a \$24 million cap. According to EPIC investment planning documents, \$368.8 million has been budgeted for applied research and development, technology demonstration and deployment, and market facilitation from 2012 to 2014.³³⁶

³³⁵ DSIRE. 2013. California Public Benefits Funds for Renewables and Efficiency. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA05R

³³⁶ Ibid

Over the 15-year life of California RD&D programs, investments have totaled \$839 million and attracted \$1.35 billion in match funding.³³⁷ The current version of California's R&D program is named the Public Interest Energy Research (PIER program and it is was estimated that 2,800 direct and 4,500 indirect full-time jobs were sustained during 2012 as a result of PIER-funded projects and these projects will produce 27,700 direct, indirect, and induced jobs in the long-term. California utilizes PIER-funded R&D to inform energy codes and appliance efficiency standards, claiming that \$27.6 million invested from 1999 to 2008 will result in \$10.1 billion in benefits to ratepayers between 2005 and 2025 from 122,600 gigawatt-hours of electricity savings and 1.1 billion therms of natural gas savings.

New York: The New York Public Service Commission (PSC) established a system benefits charge (SBC), in 1996 to support energy efficiency, education and outreach, research and development, and low-income energy assistance. SBC funds are collected from customers of the state's six investor-owned electric utilities. The SBC program is administered by NYSERDA and only customers that pay the SBC are eligible for assistance through the programs it funds.

The SBC has gone through several iterations since it was first created in 1996 and was most recently extended for an additional five years through December 31, 2016. The renewed authorization (SBC IV) shifted many activities and programs away from some areas that had previously been funded by the program. For example, the various demand-side energy efficiency programs under the Energy Smart program were shifted to state's Energy Efficiency Portfolio Standard (EEPS) which is funded separately. SBC IV funds the Technology and Market Development (T&MD) Program and has an annual budget of about \$104.7 million per year for 2012 through 2016.³³⁸ The mission of the T&MD program is to "test, develop, and introduce new technologies, strategies and practices that build the statewide market infrastructure to reliably deliver clean energy to New Yorkers." Specific objectives include: (1) moving new or under-used technologies and services into marketplace to serve as a "feeder" to help achieve EEPS & RPS goals; (2) validating emerging energy efficiency, renewable, and smart grid technologies/strategies and accelerate market readiness in New York State; (3) stimulating technology and business innovation to provide more clean energy options and lower cost

³³⁷ California Energy Commission. 2011. Renewable Energy Program 2011 Annual Report To The Legislature. Accessed August 2013 at: <http://www.energy.ca.gov/2011publications/CEC-300-2011-007/CEC-300-2011-007-CMF.pdf>

³³⁸ NYSERDA. 2013. Operating Plan for Technology and Market Development Programs (2012–2016). Accessed August 2013 at: http://www.nyserdera.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserdera_tmd_semiannual_report.pdf

solutions, while growing New York State’s clean energy economy; and (4) spurring actions and investments to achieve results distinct from incentive-based programs.³³⁹

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³³⁹ NYSERDA. 2013. Operating Plan for Technology and Market Development Programs (2012–2016). Accessed August 2013 at: http://www.nyserdera.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserdera_tmd_semiannual_report.pdf

12 Property Assessed Clean Energy (PACE) Programs

Potential Action for Consideration				
<ul style="list-style-type: none">• Pass enabling legislation at the State level to remove barriers to local administration of Property Assessed Clean Energy programs, which support energy conservation and renewable energy.				
GHGs and Costs in Washington	GHG Reductions (MMTCO ₂ e)			Cost
	2020	2035	2050	(\$/mtCO ₂ e)
\$10 million annual investment for 5 years	0.02	0.05	0.06	\$(171)
Implementation Issues and Lessons Learned				
<ul style="list-style-type: none">• Must define qualifying building types (residential, commercial, industrial) and qualifying improvements (e.g., energy efficiency, renewable energy)• PACE programs to date have been small because the funding mechanism is in its infancy• Must establish the assessment lien position relative to mortgages and other tax assessments. There are currently legal challenges related to this issue in the residential sector that have largely stalled residential PACE implementation.• Requires seed funding for early loans, or involvement of private firms to manage debt.• There are several PACE lending models, such as warehoused, pooled bond, or owner-arranged/open market.				
Potential Costs and Benefits to WA Consumers		Potential Costs and Benefits to WA Businesses		
<ul style="list-style-type: none">• Elimination of large up-front costs for energy retrofits combined with a long loan payback period of up to 20 years.• Energy efficiency or renewables improvements will generally yield net savings on annual energy purchases.• Consumers incur the cost of the loan principle and interest; however, interest paid on PACE loans is tax deductible.³⁴⁰		<ul style="list-style-type: none">• Opportunities for local construction businesses and contractors to retrofit buildings with energy efficiency and renewables technology.• Increased economic output and opportunity for job creation not only in the PACE program, but also for businesses impacted by PACE such as local builders, banks, and private lenders.• Businesses participating in a PACE program will incur cost of the loan principle and interest; however, interest paid on PACE loans is tax deductible.³⁴¹		
Summary of Screening Criteria				
<p><i>Does the policy target an emissions source of significant magnitude in Washington?</i></p> <p>PACE programs target emissions from electricity and fossil fuel consumption in the residential, commercial and industrial sectors. Together, the electricity consumption sector and residential/commercial/industrial (RCI) sector accounted for about 40% of State emissions in 2008.³⁴²</p> <p><i>What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?</i></p> <p>Since PACE programs only provide financing and are generally administered at the local level, costs to the state are minimal for oversight and general administration functions only. Some resources are also</p>				

³⁴⁰ Clean Technica. Open PACE Markets Provide Most Benefit to Property Owners. Accessed August 2013 online at: <http://cleantechnica.com/2013/05/21/open-pace-markets-provide-most-benefit-to-property-owners/>

³⁴¹ Clean Technica. Open PACE Markets Provide Most Benefit to Property Owners. Accessed August 2013 online at: <http://cleantechnica.com/2013/05/21/open-pace-markets-provide-most-benefit-to-property-owners/>

³⁴² Department of Ecology. 2010. Washington State Greenhouse Gas Emissions Inventory 2008 <https://fortress.wa.gov/ecy/publications/publications/1002046.pdf>

required initially to pass enabling legislation. Ultimately, the majority of costs associated with GHG reductions are incurred by participating consumers. To date, the volume of reductions from PACE programs has been small because most programs are still in their infancy and have limited fund sizes (typically less than \$30 million). Some programs also fund water conservation and other non-energy projects which contributes to the observed small volume of reductions.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

PACE is discrete and comprehensive as a clean energy financing mechanism that is repaid by an assessment added to the owner's property tax bill. The tax lien is unique to PACE and provides security to lenders and allows them to lend at favorable interest rates. These tax liens stay with the property rather than the property owner which alleviates concerns that investments will outlive the period of ownership before the asset is sold. The property and project types, as well as the participant eligibility criteria are subject to state and or local program requirements.

Can the policy be meaningfully implemented or influenced at the State level?

PACE programs are generally implemented at the local level where property taxes are managed but require enabling legislation at the state-level. The key features that often must be added to existing state law to enable PACE include (1) the authority to finance improvements on private property; (2) the authority to finance renewable energy and energy efficiency improvements; and (3) an opt-in feature.³⁴³

12.1 Introduction

Property assessed clean energy (PACE) programs provide a unique loan mechanism to property owners for the deployment of energy efficient technologies and renewable energy at residential, commercial and industrial facilities. These loans allow owners to pay for energy improvements over time, avoiding the barrier of upfront investment costs. By promoting energy conservation and renewable power generation, PACE programs capture energy cost savings and realize environmental co-benefits including reduced emissions from fossil energy consumption, water conservation and improved air quality.

The underlying PACE mechanism is common to all programs: a local government provides or arranges for financing that is repaid with a property tax-like assessment with a term length of up to 20-years. The tax lien is unique to PACE and provides security to lenders and allows them to lend at favorable interest rates. PACE loans can optionally stay with the property despite ownership changes. If a building owner sells their property before the PACE loan is paid off, the loan can either be paid off at the time of sale or transferred with the property to the new owner. Since commercial building ownership changes about every four to six years on average³⁴⁴, this

³⁴³ DOE. 2013. Clean Energy Finance Guide: Chapter 12. Commercial Property-Assessed Clean Energy (PACE) Financing.
http://www4.eere.energy.gov/wip/solutioncenter/finance_guide/sites/default/files/docs/ch12_commercial_pace_all.pdf

³⁴⁴ Johnson Controls. 2010, An Awakening in Energy Efficiency: Financing Private Sector Building Retrofits. Accessed September 2013 at:

feature is critical for building owners to invest in efficiency measures with payback periods of four years or more.

Interest in residential PACE was stymied in 2010 when the Federal Housing Finance Agency (FHFA) ordered Fannie Mae and Freddie Mac to stop buying PACE encumbered mortgages due to concerns regarding PACE loans that acquire a priority lien over existing mortgages.³⁴⁵ A few law suits have been filed in response to the FHFA's position on residential PACE but all have been unsuccessful. Some residential PACE programs have continued to move forward with PACE loans receiving a subordinate lien position relative to existing mortgages, however, this strategy results in increased risk to private investors and significantly inhibits their interest in investing in PACE programs. The FHFA limitations do not affect commercial PACE and many programs have demonstrated early successes. As more commercial PACE programs have launched and achieved early stage success in the last two years, interest in passing or amending flawed legislation has increased³⁴⁶.

Today, 30 states including Oregon, California, and the District of Columbia can implement PACE programs. Each existing PACE program is unique and reflects different enabling acts, budgetary resources, program administration strategies, and level of community and local government support³⁴⁷. In addition, the property and project types eligible for PACE financing, as well as the participant eligibility criteria are subject to individual state and or local program requirements. Although PACE programs are authorized by state law, they are typically administered at the city or county level. This means that PACE programs require some initial legwork by state governments to pass PACE-enabling legislation but carry very limited costs at the state level on an ongoing basis. State legislation generally includes but is not limited to the following elements:³⁴⁸

- Definition of qualifying building types (e.g., residential, commercial) and qualifying improvements (e.g., energy efficiency, renewable energy)
- Granting of authority to municipalities to establish an energy improvement district and financing program, issue debt to finance projects, and use other legally available funds

http://www.johnsoncontrols.com/content/dam/WWW/jci/be/solutions_for_your/private_sector/Financing_PrivateSector_whitepaper_FINAL.pdf

³⁴⁵ Federal Housing Finance Agency (FHFA). FHFA Statement on Certain Energy Retrofit Loan Programs. (July 6, 2010). Accessed July 2013 at: <http://www.fhfa.gov/webfiles/15884/PACESTMT7610.pdf>

³⁴⁶ PACENow. 2013. Annual Report. Accessed August 2013 at: <http://pacenow.org/wp-content/uploads/2013/06/Annual-report-6.18.13.pdf>

³⁴⁷ PACENow. 2013. Annual Report. Accessed August 2013 at: <http://pacenow.org/wp-content/uploads/2013/06/Annual-report-6.18.13.pdf>

³⁴⁸ PACENow. 2013. C-PACE Legislation Checklist. Accessed August 2013 at: <http://pacenow.org/wp-content/uploads/2013/06/PACENow-C-PACE-Legislative-Checklist.pdf>

- Establishment of the assessment lien position relative to mortgages and other taxes and assessments
- Specification of whether the assessment lien stays with property upon sale

One of the primary challenges state and local programs face when launching a PACE program is acquiring seed funding, or a pool of funding dollars from which lending can occur. Many active PACE programs launched with seed funding provided by federal grants through the American Recovery and Reinvestment Act of 2009 (ARRA). However, ARRA funds and other potential federal funding sources have essentially dried up as a result of cuts to federal spending. Likewise, the recent economic recession in the U.S. has led to budgetary issues at the state and local government levels as well. Three common models for PACE lending are summarized below.^{349,350}

Warehoused. In this model, a large line of credit (in the millions of dollars) is secured from one or more lenders that can be used on an as-needed basis to fund projects within a defined period of time. The loans from financed projects can be aggregated and sold on the secondary market and sale proceeds are used to replenish the line of credit. Alternatively, the program administrator could use general or reserve funds to seed a loan pool.

Pooled Bond. In this model, the program administrator aggregates applications for PACE financing from building owners and issues a revenue bond(s) to fund the projects. The primary challenge with this method is the time required for the program administrator to collect a sufficient number of applications. The resulting project delay could prove unattractive to building owners who need a fixed project implementation timeline and certainty about the interest rate, which may change while other project applications are being accumulated.

Owner-arranged/Open Market. In this model, program participants arrange their own financing and use the enforceability of the property lien as security. The hands-off nature of this model is administratively less complex and therefore less costly to implement than other models, and it provides participants with flexibility to negotiate their own rates, terms, conditions, and schedules. This model, however, is likely only accessible to participants with significant holdings due to the large transaction costs associated with arranging a loan. In

³⁴⁹ DOE. 2013. Clean Energy Finance Guide: Chapter 12. Commercial Property-Assessed Clean Energy (PACE) Financing.
http://www4.eere.energy.gov/wip/solutioncenter/finance_guide/sites/default/files/docs/ch12_commercial_pace_all.pdf

³⁵⁰ M.C. Furman Associates and ICF International. 2013. Montgomery County, Maryland Commercial Building Energy Efficiency Policy Study. Accessed August 2013 at:
<http://www6.montgomerycountymd.gov/content/dep/downloads/Energy/FINALCommercialandMulti-FamilyStudy.pdf>

addition, it may be difficult to package loans with different terms and conditions for resale on the secondary market using this model, limiting program scalability.

Unlike utility energy programs funded through a system benefits charge or cost recovery rate adjustments assessed to all ratepayers, participation in PACE is voluntary. PACE programs can complement utility programs by financing “deeper” energy retrofit measures and measures for smaller customers that are beyond the scope of utility programs. The low interest rates and relatively long repayment terms means the PACE programs can create an immediate positive cash flow to building owners. In other words, energy cost savings achieved through PACE-financed energy improvements, can exceed loan repayment costs on an annual basis resulting in net savings.

PACE programs can become self-funded through loan repayments (i.e., revolving fund), however, there are necessary implementation and subsequent administrative costs. The size and scope of each individual PACE program determines administrative costs, but costs normally comprise of start-up costs, seed funding, initial expenses, and ongoing operating costs to maintain the program. These costs include municipal personnel to oversee each program, fees paid to third party administrators and/or lenders, and marketing expenses. Municipalities may be able to recover some of these administrative costs through application or project fees, increased interest rates, or other sources such as grants.³⁵¹

Though not technically a cost, many PACE programs allocate budget for a debt service reserve fund utilized in the event of late payments or defaults by participants. The Climate Smart Loan Program in Boulder, Colorado, set aside \$2.4 million as a reserve fund to help secure program bonds while distributing over \$9 million in PACE financing.³⁵² There are many ways to fund the reserve, but a common method is using assessment bonds to add a percentage fee rate (sometimes 5-10 percent) to the financed amount for each participant, allowing the participants to pay for it.³⁵³ Adding this additional rate, however, may make participants hesitant about the cost of PACE financing, so an appealing option to consumers is to have PACE communities use

³⁵¹ Sustainable Cities Institute. Property Assessed Clean Energy Program Overview. Accessed August 2013 online at: http://www.sustainablecitiesinstitute.org/view/page.basic/class/feature.class/Lesson_PACE_Financing

³⁵² National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: <http://www.nrel.gov/docs/fy11osti/52231.pdf>

³⁵³ Note that if that bond does not experience any defaults, then that the PACE program can use that reserve money to make the final loan payment to the property owner.

their own funds to stock the reserve.³⁵⁴ It is important to note that loan eligibility criteria are strict³⁵⁵, and default rates on PACE loans have been very low.³⁵⁶

Research conducted by ECONorthwest in April 2011 suggests that PACE programs have the potential to generate significant economic and fiscal impacts. Specifically, modeling of hypothetical PACE programs in Columbus, Ohio, Long Island, New York, Santa Barbara, California, and San Antonio, Texas indicates that \$4 million in total PACE project spending across the four cities (\$1 million in spending in each city) will generate \$10 million (about \$67,000 per job), on average.³⁵⁷

ECONorthwest also modeled the gross spending effects at the local level of consumer energy cost savings achieved through the four hypothetical programs. The analysis estimates that for every \$1,000 in annual energy cost savings lasting 25 years, economic output would increase \$21,000, personal income would increase \$7,000, combined federal, state and local tax revenue would increase \$3,000, and 0.2 local jobs would be created.³⁵⁸ The study notes that the results of the modeling effort do not account for any utility revenue losses that would partially offset impacts of increased consumer spending. These analyses suggest that enabling PACE programs in Washington has the potential to increase economic output, tax revenue, and job creation in addition to reducing energy consumption and GHG emissions.

The next section discusses the potential for PACE programs in the State of Washington. A summary of existing PACE and their relative successes is provided in Section 12.4 with a thorough review provided in Appendix B. Section 12.2 summarizes existing work that has been done to evaluate the potential for, and impacts of, a PACE program in Washington. Section 12.3 presents original analysis conducted for this report, which evaluates the potential emission reductions and some of the associated costs and benefits of PACE in Washington in the target years 2020, 2035, and 2050.

³⁵⁴ DOE 2013, Chapter 12 p. 14.

³⁵⁵ A full list of criteria is include in Chapter 12 (page 19) of DOE's Clean Energy Finance Guide. Important criteria include that applicants have to have a clear title to the property, applicants have no recent default notices or foreclosures, applicants have no recent bankruptcies, and applicants are current on mortgage payments among other criteria.

³⁵⁶ Alliance to Save Energy. The Inception of PACE Financing, its Support, and its Potential Accessed September 2013 online at: <http://www.ase.org/resources/inception-pace-financing-its-support-and-its-potential>

³⁵⁷ ECONorthwest. 2011. Economic Impact Analysis of Property Assessed Clean Energy Programs (PACE).

Accessed August 2013 at:

<http://pacenow.org/wp-content/uploads/2012/08/Economic-Impact-Analysis-of-Property-Assessed-Clean-Energy-Programs-PACE.pdf>

³⁵⁸ Ibid

12.2 Washington Potential

State-level PACE-enabling legislation has the potential to provide a variety of benefits to Washington including energy efficiency improvements and GHG reductions in the buildings sector as well as increases in gross economic output, federal, state and local tax revenue, and clean energy jobs. GHG reductions of approximately 1,100 to 1,300 mtCO₂e per year have been estimated for PACE programs in Maine³⁵⁹ and in Boulder, Colorado.³⁶⁰ These emissions reductions are somewhat low and may not reflect the full potential of PACE since these programs are in their infancy and often have limited funding. As PACE programs mature and consumers become more aware, the potential for GHG reductions is likely to increase substantially.

The primary uses for PACE in Washington would likely be to finance participant costs associated with utility energy efficiency and renewable energy programs driven by I-937 and to finance energy conservation projects that are outside the scope of these utility programs. Consumers who participate in utility programs typically incur additional costs which can inhibit participation despite program incentives. For some programs, customer costs make up the difference between the incremental cost of energy efficiency measures and any program incentives such as rebates. For other programs, customers incur the entire cost while the program administrator provides other incentives such as technical assistance. A study of utility energy efficiency programs across the U.S. indicates that about 45 percent of the total costs of these programs are paid for directly by participants on average.³⁶¹ PACE financing could increase participation in utility programs by providing consumers with access to long-term, low-interest loans. Similarly, enabling PACE might encourage customers of utilities with limited or no demand-side energy efficiency and renewable energy programs to take action independently. With respect to potential GHG reductions, these potential uses of PACE financing would likely result in a significant amount of overlap with I-937, however, PACE would be expected to increase participation in utility-sponsored programs under I-937 and increase private investment

³⁵⁹ Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: <http://www efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf>. Estimates external to study using the following assumptions: all savings are from primary heating fuel (savings by fuel are 90% fuel oil, 5% NG, 5% Propane); 2013 Climate Registry default emission factors for CO₂, CH₄, and N₂O; IPCC Second Assessment Report GWPs.

³⁶⁰ National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: <http://www.nrel.gov/docs/fy11osti/52231.pdf>. Estimate external to study using the following assumptions: average participant savings of 1,786 kWh/yr for electricity and 74.9 therms/yr for natural gas; eGRID2012 electricity CO₂e emission factor for WECC Rockies subregion; 2013 Climate Registry default natural gas emission factors for CO₂, CH₄, and N₂O, IPCC Second Assessment Report GWPs.

³⁶¹ ACEEE. 2009. Saving Energy Cost-Effectively: A National Review of the Cost of Saved Energy through Utility-Sector Energy Efficiency Programs. Accessed August 2013 at: <http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf>

energy conservation. This increase in private investment may act to decrease the cost of utility programs.

No studies of the potential of state-enabled PACE programs in Washington were found in the research for this report; however, PACE has been recognized by the City of Seattle³⁶² and Governor Inslee³⁶³ as a policy option for attracting and leveraging public and private-sector capital to finance energy efficiency improvements in the RCI sector. Seattle's Climate Action Plan acknowledges that financing programs such as PACE will be critical to achieving "deep" energy efficiency gains from building retrofit assistance programs.³⁶⁴ The 2012 Washington State Energy Strategy indicates that Washington has considered meter-based/on-bill financing, a demand side energy efficiency financing mechanism similar to PACE.³⁶⁵

PACE programs and on-bill financing both reduce up-front costs and align the timing of costs and benefits to customers. A key feature of both program types is loan responsibility may be passed from one property owner to the next. This feature gives property owners incentive to invest in energy efficiency upgrades even if they plan to sell the property in the near-term. The primary difference between on-bill financing and PACE is that on-bill financing requires loan payment through a tariff on utility bills while PACE utilizes a property tax-like assessment. The tax lien is a major advantage for PACE in attracting lenders since it provides greater security than other financing options. PACE programs also typically utilize federal grants, state or local funding sources, or traditional lenders for loans while utilities often provide loans directly in on-bill financing programs. As a result, on-bill financing programs are heavily reliant on whether utilities have the resources and expertise to comply with state-specific consumer lending laws, to become lending institutions, and to completely redesign billing systems.³⁶⁶

12.3 Quantification

The analysis described below calculates the amount of electricity savings program participants can achieve based on a hurdle rate, or minimum required rate of return on an energy conservation project. Program participants are assumed to achieve a level of annual energy cost savings that exceed the annual loan repayment including interest, thereby creating immediate

³⁶² City of Seattle. Climate Action Plan: Building Energy TAG Preliminary Recommendations. April 23, 2011. Online at: http://clerk.ci.seattle.wa.us/~public/meetingrecords/2012/cbriefing20120423_3c.pdf

³⁶³ Inslee. n.d. Building a New Economy For Washington: Clean Technology. Accessed August 2013 at: <http://www.jayinslee.com/issues/Inslee-Jobs-Clean-Tech.pdf>

³⁶⁴ City of Seattle. Climate Action Plan: Building Energy TAG Preliminary Recommendations. April 23, 2011. Online at: http://clerk.ci.seattle.wa.us/~public/meetingrecords/2012/cbriefing20120423_3c.pdf

³⁶⁵ Washington State Department of Commerce. December 2011. 2012 Washington State Energy Strategy. Online at: http://www.leg.wa.gov/documents/legislature/ReportsToTheLegislature/2012%20WSES_23140184-41ff-41d1-b551-4675573845db.pdf (pages 109-112).

³⁶⁶ ACEEE On-bill Financing 2013.

positive cash-flow. This analysis also estimates the required levelized cost of saved energy to achieve the assumed hurdle rates but does not attempt to determine if real conservation opportunities exist in Washington at this cost. Further analysis may be warranted to understand the supply and associated levelized cost of real opportunities for consumers in Washington that are not already being captured by utility programs under the Energy Independence Act, Initiative 937.

This analysis focuses solely on potential electricity savings in the commercial sector since several of the assumptions used in this analysis were derived from the *Sixth Northwest Conservation and Electric Power Plan*³⁶⁷ which does not analyze direct-use natural gas in detail and since there is currently significant uncertainty in the legal status of the residential sector as discussed above. Further, most lenders are more interested in commercial sector PACE financing because it is more lucrative and dollars per project are generally higher.

Ultimately, it can be expected that a share of PACE financing will be used to achieve natural gas savings at a level in which the cost-effectiveness is in equilibrium with the cost effectiveness of electricity conservation measures. In other words, participants will generally aim to maximize energy cost savings and, as a result, will not choose to implement an electricity conservation measure if a natural gas conservation measure is more cost-effective. Determining the available natural gas conservation supply that is in equilibrium with electricity conservation supply on a cost-effectiveness basis is beyond the scope of this analysis.

12.3.1 Methodology

The foundation of the methodology used to quantify the energy and GHG impacts of a PACE program in Washington is the participant hurdle rate. The hurdle rate represents the amount by which energy cost savings accrual rate from financed conservation measures must exceed the PACE loan repayment rate (including interest). For example, a building owner with a hurdle rate of 20 percent and a loan repayment rate of \$10,000 per year will require that implemented energy conservation measures must achieve energy cost savings at least \$12,000 per year, otherwise, the building would not have participated in the program. As a result, the first step of this analysis was to establish the size and rollout schedule for a PACE fund in Washington. This analysis does not attempt to evaluate the supply and costs of real energy conservation measures available to Washington consumers, which is necessary for appropriately sizing the PACE fund. Instead, this analysis was designed to provide results that are scalable in to any size PACE fund in increments of \$50 million. To that effect, this analysis assumes a \$50 million PACE fund with a rollout schedule of \$10 million in financing provided in each of the first five years of the program. In addition, the fund is designed to be revolving in the sense that collected loan

³⁶⁷ Northwest Power and Conservation Council. 2013. Sixth Northwest Conservation and Electric Power Plan. Accessed August 2013 at: <http://www.nwcouncil.org/energy/powerplan/6/plan/>

repayment funds (including interest) minus administrative costs are immediately made available for new loans. Since interest is captured by the fund and reissued for new loans, the size of the fund grows over time as a function of the forecasted interest rate minus any defaults. The amount of loan repayment dollars for new loans provided in each program year was calculated based on the loan amount, the loan term, and the forecasted interest rate. Separate calculations were made for an assumed loan-term of 15 years and 20 years. As discussed in the previous section, this analysis focuses solely on potential electricity savings in the commercial sector since several of the assumptions used in this analysis were derived from the *Sixth Northwest Conservation and Electric Power Plan*³⁶⁸ which does not analyze direct-use natural gas in detail and there is currently significant uncertainty in the legal status of the residential sector. Further analysis may be warranted to capture natural gas and residential sector savings potential in the future.

The next step was to determine the first-year energy cost savings required to exceed annual loan repayment by assumed hurdle rates of 15 percent and 20 percent. This was done for each year between 2016 and 2050 by multiplying the total loan repayment in each year by 115 and 120 percent. First-year electricity savings were then calculated by dividing the first-year energy cost savings by the forecasted retail commercial electricity price. These electricity savings were cumulated over time to determine the cumulative annual electricity savings from PACE financed energy conservation. It should be noted that this calculation only includes cumulated electricity savings from measures that had not exceeded their useful life. For the purposes of this analysis, separate calculations were performed assuming a useful life of 15 years and 20 years. The last step in this analysis was to multiply the cumulative annual energy savings by the forecasted electricity emissions factor in each program year to calculate cumulative annual GHG reduction potential.

All calculations described above were executed using a simple spreadsheet-based model developed for this analysis. Iterative model runs were performed using different combinations of assumptions for hurdle rate, loan term, and useful measure life. The model was run using all possible combinations of high and low assumption values for participant hurdle rate, loan term, and measure life. Additionally, the model required that measure life be greater than or equal to loan term to ensure the reality that conservation measures must be lifetime cost-effective or they would not have been implemented. The results from this analysis are presented as a range of potential GHG reductions in each target year using the maximum and minimum reduction values calculated by the model for each target year..

12.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions for a scalable PACE program are included in this analysis:

³⁶⁸ Northwest Power and Conservation Council. 2010. Sixth Northwest Conservation and Electric Power Plan. Accessed August 2013 at: <http://www.nwcouncil.org/energy/powerplan/6/plan/>

- Scalable pilot program rollout includes \$10 million per year over five year beginning in 2016 (i.e., \$50 million invested by 2020)
- All loan repayment dollars (including principal and interest) are returned to the fund for re-issue in the form of new loans (i.e., revolving fund) except from administration costs
- State and local program administration costs are estimated as 50 percent of the loan interest rate in each program year and are deducted out of the revenue getting recycled back into the revolving PACE fund.
- Interest rate increases from about 6 percent in 2016, to about 6.9 percent in 2020, and then grows linearly to about 7.5 percent in 2050.
- Hurdle rate analyzed are 15 percent and 20 percent in excess of the annual loan repayment amount including principal and interest
- Conservation measure life analyzed: 15 years and 20 years
- Loan term analyzed: 15 years and 20 years
- Retail commercial sector electricity prices increase linearly from \$93.66/MWh in 2016 to \$99.20/MWh in 2020, and then decline 0.35 percent per year through 2050 (in 2013 dollars)
- Electricity savings are proportional to electricity cost savings (demand savings and demand cost savings are not captured)

This analysis relies on the data sources summarized in the table below.

Table 61: Primary data sources used to quantify GHG impacts of a scalable PACE program in Washington

Data	Source
Loan interest rate forecast (AA Utility Bond interest rate used as a proxy)	EIA. 2013. Annual Energy Outlook 2013. Macroeconomic Indicators (Table A20) http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf
Retail commercial electricity price forecast (extrapolated from 2030 through 2050 and adjusted from 2006\$ to 2013\$)	Northwest Power and Conservation Council. 2010. Sixth Northwest Conservation and Electric Power Plan http://www.nwcouncil.org/energy/powerplan/6/plan/
Electricity CO ₂ e emission factor for Northwest Power Pool	EPA. 2012. eGRID2012 year 2009 Summary Tables http://www.epa.gov/cleanenergy/documents/egrid2012V1_0_year09_SummaryTables.pdf
Electricity emission factor improvement rate	EIA. 2013. Annual Energy Outlook 2013. Electric Power Projections for Northwest Power Pool Area http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013&subject=0-AEO2013&table=62-AEO2013&region=3-21&cases=ref2013-d102312a

12.3.3 Results

This analysis estimates that for every \$50 million of commercial sector PACE financing provided equally over the first five program years, carbon dioxide emission could be reduced by up to 0.03 MMTCO₂, 0.07 MMTCO₂, and 0.08 MMTCO₂ in 2020, 2035, and 2050, respectively. These potential reductions are likely to overlap significantly, but not entirely, with reductions from I-937 if the PACE is implemented in the service territory of utilities subject to I-937. The table below summarizes the results of potential emission reductions estimated for different sets of input assumptions. The sets of assumptions include all possible combinations of high and low assumptions for participant hurdle rate, loan term, and measure life with a requirement that loan term cannot exceed measure life.

Figure 10. Potential Emission Reductions for Every \$50M in PACE Financing during the First 5 Program Years³⁶⁹

Hurdle Rate (%)	Loan Term (years)	Measure Life (years)	Potential Emission Reductions (MMTCO ₂ /\$50M)		
			2020	2035	2050
15%	15	15	0.02	0.04	0.06
15%	15	20	0.02	0.06	0.07
15%	20	20	0.02	0.05	0.05
20%	15	15	0.03	0.04	0.06
20%	15	20	0.03	0.07	0.08
20%	20	20	0.02	0.05	0.05
Estimated Range of Potential Reductions			0.02-0.03	0.04-0.07	0.05-0.08

These results are intended to be scalable. For example, increasing total PACE financing during the first five program years by a factor of ten, from \$50 million over five years to \$500 million over five years, would be expected to increase potential emission reductions by a factor of ten, or up to 0.8 MMTCO₂ per year by 2050. Similarly, reducing the funding by a magnitude of ten would reduce emissions accordingly.

The average costs and reductions for the six combinations of input assumptions discussed above were used to calculate a NPV cost savings of about \$171 per metric ton of carbon dioxide equivalent for the period 2020-2035. As shown in the table below, this value is the result of about \$103 million in cost savings and GHG reductions of just over 0.6 million metric tons of carbon dioxide equivalent during that time period.

Table 62. Costs of a PACE program

Million \$USD	2020	2035	NPV 2020-2035 ^a
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³⁶⁹ This assumes financing is provided in equal amounts over the first five program years

Cost to Government	\$8.90	\$(1.00)	\$1.70
Loan Pool Funding	\$10.00	\$-	\$8.20
Administrative Costs	\$0.30	\$0.30	\$1.70
Loan Repayment Revenue	\$(1.40)	\$(1.20)	\$(8.20)
Cost to Consumers	\$(5.50)	\$(19.00)	\$(104.00)
Loan Repayment	\$1.40	\$1.20	\$8.20
Energy Cost Savings	\$(6.90)	\$(20.00)	\$(113.00)
Net Costs	\$3.40	\$(19.60)	\$(103.00)
Total GHG Reductions (MMTCO₂e)	0.02	0.05	0.60
Cost per Metric Ton CO₂e (\$)			\$(171.00)

^a 5 percent discount rate applied, NPV 2013

Costs captured in this analysis include initial funding of the loan pool, program administration costs, loan repayment, and consumer energy cost savings. Loan repayment only represents a wealth transfer from participants back to the government. Administration costs were taken as half the interest rate in year program year and subtracted out of the revenue getting recycled back into the revolving PACE fund. Benefits captured include the value of energy cost savings for participants. Participant energy cost savings may translate into utility lost revenue, however, those losses were not quantified in this analysis. In addition, all tax revenue associated with the program is considered a wealth transfer and, thus, is ignored in this analysis. It should be noted that PACE literature suggests that it is likely that jobs will be created as result of PACE-induced spending and that this may support local business and the economy, but these benefits are not quantified in this analysis.

12.4 Implementation History

This section summarizes PACE programs implemented in other jurisdictions. The following programs that have produced PACE performance data are included:

Maine PACE Loan Program: Launched in April 2011, the Maine PACE Loan Program provides \$6,500 to \$15,000 loans to Maine homeowners to finance the cost of eligible energy saving improvements and offers repayment periods of 5, 10, or 15 years at a fixed interest rate of 4.99 percent APR, with no processing fees.³⁷⁰ PACE loans are available for residential buildings with one to four units that meet a set of minimum underwriting requirements and are located in municipalities that have passed a PACE ordinance. In addition, energy efficiency improvements packages must generate savings of at least 20 percent of home energy usage or 25 percent of heating and hot water energy usage to qualify for a PACE loan. PACE-eligible energy

³⁷⁰ DSIRE. 2013. Maine PACE Loans. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=ME20F

improvements include, but are not limited to: insulation, air sealing, energy efficient heating systems, lighting and appliances, windows and doors, and solar energy systems. Maine's PACE law dictates that loans do not have a senior priority over a primary home mortgage.³⁷¹

As of February 2013, a total of 158 Maine municipalities had passed PACE ordinances and entered into an agreement with Efficiency Maine to administer the loan program on their behalf. Residents of these towns comprise about three quarters of the state population and have submitted a total of more than 1,800 loan applications³⁷². Efficiency Maine has established a \$20.4 million revolving loan fund for the PACE and PowerSaver Loan Program³⁷³ primarily using Federal grant money through the DOE BetterBuildings Program. As homeowners pay back the loans, the loan fund will be replenished for the next round of homeowner applicants³⁷⁴.

Boulder County, Colorado, ClimateSmart Loan Program (CSLP): The ClimateSmart Loan Program offered loans to Boulder County property owners who wanted to make energy efficiency and renewable energy improvements to their property. In June 2010, residential financing was cancelled and the loan program was put on-hold until issues with the FHFA and federal mortgage regulators, Fannie Mae and Freddie Mac, could be resolved. Subsequently, the commercial loan program was also suspended.³⁷⁵

The Boulder County, Colorado, CLSP was the first test of PACE financing on a multi-jurisdictional level (involving individual cities as well as the county government). It was also the first PACE program to comprehensively address energy efficiency measures and renewable energy, and it was the first funded by a public offering of both taxable and tax-exempt bonds. Initiated in 2009, the first phase of the CSLP included two rounds of residential project financing and resulted in about \$9.8 million in project loans. Associated program costs and fees were about \$0.8 million and funding of a reserve account for the bonds added \$2.4 million.³⁷⁶

The minimum borrowing level for the first phase of the CLSP was \$3,000 per home. The maximum borrowing limit for open loans (using taxable bonds), was the lesser of 20 percent of

³⁷¹ Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: <http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf>

³⁷² Ibid

³⁷³ The PowerSaver Loan Program covers the same home energy improvements as PACE, but offers a wider range of loan amounts, is available statewide, and has slightly different eligibility criteria.

³⁷⁴ Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: <http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf>

³⁷⁵ Boulder County, Colorado Website. Accessed August 2013 at: <http://www.bouldercounty.org/env/sustainability/pages/cslp.aspx>

³⁷⁶ National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: <http://www.nrel.gov/docs/fy11osti/52231.pdf>

actual property value, or \$50,000. For income-qualified loans (using tax-exempt bonds), the maximum borrowing limit was set to \$15,000 per home. Interest rates on PACE loans ranged from 5.2 percent to 6.8 percent depending on the type of bond and the issue. PACE loans were repaid through a 15-year assessment on each participant's property taxes (senior lien). If a property owner sells a PACE-assessed home or business, the assessment stays with the property, with responsibility passing to the next owner until the debt is paid.³⁷⁷

Sonoma County, California, Sonoma County Energy Independence Program (SCEIP): Sonoma County's Energy Independence Program gives residential and non-residential property owners the option of financing energy efficiency, water efficiency and renewable energy improvements through a voluntary assessment on their property tax bills. The property tax assessments are attached to the property, not the property owner, meaning that if the property is sold, the assessment stays with the property. In 2010, Sonoma County's PACE program was temporarily suspended in response to the FHFA's statement of concerns regarding residential PACE financing on July 10, 2010 but was immediately re-opened by the Sonoma County Board of Supervisors on July 13, 2010.³⁷⁸

The minimum funding level offered by SCEIP is \$2,500 and assessments may not exceed 10 percent of the property value³⁷⁹. In addition, the sum of all debt associated with the property cannot exceed 100 percent of the value of the property. The SCEIP can be combined with utility and state rebates, but financing will only be available for the post-incentive cost. Tax credits will not affect the amount of financing available³⁸⁰. The repayment period is 10 years for amounts from \$2,500 to \$4,999 and projects over \$5,000 may be repaid over a term of either 10 or 20 years, at the property owner's option. Projects of \$60,000 up to \$500,000 require approval by the Program Administrator, and projects over \$500,000 require specific approval by the Board of Supervisors. The current interest rate for SCEIP assessment contracts is 7 percent simple interest. The interest rate is fixed at the time the assessment contract and implementation agreement are signed and will not rise.³⁸¹

Commercial and industrial properties must first have an energy audit before participating in the program. Energy audits are not required for residential participants, but they are strongly

³⁷⁷ Ibid

³⁷⁸ DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F

³⁷⁹ Sonoma County Energy Independence Program FAQs. Accessed August 2013 at: <http://residential.sonomacountyenergy.org/lower.php?url=faqs-75>

³⁸⁰ DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F

³⁸¹ Sonoma County Energy Independence Program FAQs. Accessed August 2013 at: <http://residential.sonomacountyenergy.org/lower.php?url=faqs-75>

recommended. Beginning March 1, 2011, the SCEIP offers rebates of up to 75 percent for the cost of energy analyses performed by certified raters.³⁸²

A key SCEIP enhancement effective July 1, 2011, is the requirement of achieving 10 percent energy efficiency improvement on the property prior to (or along with) the financing of renewable generation upgrade projects. This approach supports SCEIP's regional goal to "reduce and produce," and it strengthens the market position of the SCEIP assessment portfolio.³⁸³

³⁸² DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F

³⁸³ Ibid

13 Feed-in-Tariff

Table 63: Potential Costs and Benefits of a Feed-in-Tariff to Washington Consumers and Businesses

Potential Action for Consideration				
<ul style="list-style-type: none"> Replace Washington's existing combination of net metering and a tax incentive mechanism with a Feed-in-Tariff in Washington. 				
GHGs and Costs in Washington	GHG Reductions (MMTCO ₂ e)			Cost (\$/mtCO ₂ e) ³⁸⁴
	2020	2035	2050	
Program cap of 375 MW (scalable)	0.5	0.5	0.5	\$30 to \$500
Implementation Issues and Lessons Learned				
<ul style="list-style-type: none"> The success of a FIT policy depends on many variables, including existing renewable energy generation, community acceptance of renewable energy and associated costs, and interconnection codes and standards.³⁸⁵ Whether to base rates on cost of generation or avoided cost Program caps serve to moderate the potential cost to ratepayers and system integration impacts of introducing a large number of FIT-funded renewable resources, while project caps can serve to moderate the number of large projects and/or broaden the type of technologies.³⁸⁶ Whether to focus on small-scale or large-scale projects Payments need to be high enough to attract investors without resulting in windfall profits and undue burden on ratepayers.³⁸⁷ Complexities include interconnection codes, standards and practices, metering requirements and the siting process for renewable energy systems.³⁸⁸ Must consider contract length, interconnection rules and agreements, program and project caps, tariff revisions, payment differentiation and bonus payments.³⁸⁹ 				
Potential Costs and Benefits to WA Consumers		Potential Costs and Benefits to WA Businesses		
<ul style="list-style-type: none"> As FIT programs are supported by ratepayers through above-market costs, electricity rates are likely to increase. The resulting impact to the average household electricity bill is undetermined in the U.S., as FIT programs are still in their infancy.³⁹⁰ Germany's FIT cost consumers a 3% rate increase in the lifetime of the program, with a 		<ul style="list-style-type: none"> As FIT programs are supported by ratepayers through above-market costs, electricity rates are likely to increase. As FIT programs are still in their infancy in the US, the impact to businesses is still undetermined. 		

³⁸⁴ 5 percent discount rate, NPV 2013

³⁸⁵ The National Association of Regulatory Utility Commissioners (NARUC). *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010. Report accessed August 2013 at <http://www.naruc.org/Publications/NARUC%20Feed%20in%20Tariff%20FAQ.pdf>

³⁸⁶ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

³⁸⁷ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

³⁸⁸ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

³⁸⁹ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

³⁹⁰ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

5% increase in 2008 alone, averaging \$2.66 to \$8.00 per month.³⁹¹

Summary of Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?

In 2010, the electricity sector accounted for 21.5 percent of statewide GHG emissions, emitting 20.7 MMTCO₂e.³⁹² In 2010, conventional hydroelectric accounted for about 66 percent of the electricity generation, while natural gas, nuclear and coal accounted for 10 percent, 8.9 percent and 8.2 percent respectively.³⁹³ Coal and natural gas accounted for about 16.4 percent (15.8 MMTCO₂e) and 5 percent (4.8 MMTCO₂e) of statewide GHG emissions respectively.³⁹⁴

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

The German FIT is a success and is considered to be the ‘international gold standard’.³⁹⁵ In Germany, the cost of reductions for solar in 2010 was €537 or (\$714)/mtCO₂e with a volume reductions of 7 MMTCO₂e, while the cost of reductions for wind was €44 or (\$58.5)/ mtCO₂e with volume of reductions of 27 MMTCO₂e.³⁹⁶

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

FIT is a discrete and comprehensive policy. FIT can enhance the deployment of renewable energy and help states meet their Renewable Portfolio Standards (RPS) by providing another revenue stream to deploy more renewable generation resources.

Can the policy be meaningfully implemented or influenced at the State level?

FIT policy could be meaningfully implemented or influenced at the state level dependent on program design.

13.1 Introduction

Although Washington’s GHG emissions from the electricity sector are small relative to the contribution of this sector in other regions, in absolute terms they represent 20.7 MMTCO₂e, or 21.5 percent of statewide emissions. Washington has recognized the potential to reduce these emissions through further implementation of clean, renewable energy sources, implementing a renewable portfolio standard (RPS) through Initiative 937 to encourage utilities to invest in renewable sources. A FIT can help accelerate the deployment of renewable energy and has the ability to target small, distributed generation of renewable energy by providing a fixed incentive.

³⁹¹ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

³⁹² Washington State Department of Ecology. *Washington State Greenhouse Gas Emissions Inventory 2009-2010*. December 2012. Report accessed August 2013 at <https://fortress.wa.gov/ecy/publications/publications/1202034.pdf>

³⁹³ <http://www.eia.gov/electricity/state/Washington/>

³⁹⁴ Washington State Department of Ecology. *Washington State Greenhouse Gas Emissions Inventory 2009-2010*. December 2012.

³⁹⁵ Institute for Self Reliance. *U.S. CLEAN Programs: Where Are We Now? What Have We Learned?* June 2012. Report accessed August 2013 at <http://www.ilsr.org/wp-content/uploads/2012/06/US-CLEAN-programs-ilsr.pdf>

³⁹⁶ Marcantonini and Ellerman. *The Cost of Abating CO2 Emissions by Renewable Energy Incentives in Germany*. Accessed August 2013 at: http://cadmus.eui.eu/bitstream/handle/1814/25842/RSCAS_2013_05rev.pdf?sequence=1

These small, customer-owned renewable resources might otherwise be unavailable to the electric utilities

A FIT is a policy mechanism designed to accelerate investment in and deployment of renewable energy technologies by offering long-term contracts with a set price to renewable energy producers. The FIT provides certainty to potential energy producers by establishing guaranteed price schedules and eliminating the need for contractual negotiations with utilities, for eligible projects. The FIT payment design varies, and is often differentiated by technology, size of project, and resource quality. Using higher payment levels may incentivize a certain type or size of resource, helping to meet policy goals such as an RPS or a goal to increase distributed resources.³⁹⁷

Guaranteed contract terms inherent in FIT policies enable project developers to finance a larger proportion of the project with debt financing, as opposed to equity, which puts further downward pressure on the cost of capital. FIT, which place a legal obligation on utilities to purchase electricity from renewable energy generators at a guaranteed rate for a determined length of time, are most effective in encouraging private finance. They are long-term contracts with a highly credit-worthy entity and a strong balance sheet and have driven relatively fast scale-up of renewable energy markets.³⁹⁸

A 2009 study examined FIT policy in Europe and the United States and concluded that FIT could unlock the potential of dispersed generation and community ownership of renewable energy while decreasing the economic and legal costs of doing business and increasing the social and economic benefits.³⁹⁹ Experience around the world suggests that FITs could be used effectively to meet a number of U.S. state policy goals, including job creation, economic development, and meeting state renewable energy targets.⁴⁰⁰ Moreover, FITs can be fine-tuned to encourage particular project attributes with respect to technology type or project size and they can be flexibly adapted to match different electricity market structures.

FITs are focused on setting the right price to drive renewable energy development while RPS policies are focused on the quantity of renewable energy deployment leaving the price up to the marketplace. FITs can help fulfill an RPS with payments structured to encourage various

³⁹⁷ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

³⁹⁸ American Council on Renewable Energy. *Strategies to Scale-Up U.S. Renewable Energy Investment*. 2013. Accessed September 2013 at: <http://www.acore.org/images/uploads/Strategies-to-Scale-Up-US-Renewable-Energy-Investment.pdf>

³⁹⁹ Institute for Self Reliance. *Feed-in tariffs in America Driving the Economy with Renewable Energy Policy that Works*. April 2009. Report accessed August 2013 at <http://www.ilsr.org/feedin-tariffs-america-driving-economy-renewable-energy-policy-works/>

⁴⁰⁰ National Renewable Energy Laboratory (NREL). *State Clean Energy Policies Analysis (SCEPA) Project: An Analysis of Renewable Energy Feed-in Tariffs in the United States*. June 2009. Report accessed August 2013 at <http://www.nrel.gov/docs/fy09osti/45551.pdf>

targeted technologies and may create a stronger price incentive for investors resulting in higher project development. However, FIT rates are not always aligned with the market and program costs may be high in comparison to an RPS program, and therefore some argue that RPS may be a more sustainable policy in the long run.⁴⁰¹

As both RPS and FIT are designed to enhance increase the deployment of renewable energy they can be structured to work together. An RPS establishes a target for renewable generation; a FIT provides a mechanism for buying renewable generation from the utility's customers. A number of states have recently implemented FITs⁴⁰² and several utilities have launched utility-specific FIT policies to help meet their RPS. RPS policies require electric utilities to provide renewable electricity to their customers, typically as a percentage of total energy use; thereby prescribing how much customer demand must be met with renewables. In 2006, Washington passed Initiative 937 and became the second state after Colorado to pass a RPS by ballot initiative. Initiative 937 calls for electric utilities that serve more than 25,000 customers in the state of Washington to obtain 15 percent of their electricity from new renewable resources by 2020 and to undertake all cost-effective energy conservation. Of Washington's 62 utilities, 17 are considered qualifying utilities, representing about 81 percent of Washington's load.⁴⁰³

In May 2005, Washington enacted Senate Bill 5101, establishing production incentives for individuals, businesses, and local governments that generate electricity from solar power, wind power or anaerobic digesters.⁴⁰⁴ Washington's FIT policy mechanism, called the Renewable Energy Investment Cost Recovery Incentive Program⁴⁰⁵, opened in 2006 and is optional for utilities. However, for participating utilities those do choose to participate by providing contracted pay rates to eligible generators specified by the legislation. The utilities' payments are fully reimbursed by the state for the contracted cost through a credit against their public utility tax liability up to a specified limit. The program expires in 2020. The tariff legislated rates are set between \$0.12/kWh to \$0.54/kWh for eligible solar, wind, and anaerobic digestion projects, with ranges depending on technology type and in-state manufacturing designation. Projects may

⁴⁰¹ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

⁴⁰² California, Hawaii, Vermont, and Washington were the first states in the U.S. to establish feed-in tariffs (<http://www.epa.gov/statelocalclimate/state/topics/renewable.html>)

⁴⁰³ Department of Commerce EIA Reporting Website. Accessed August 2013 at:

<http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx>

⁴⁰⁴ DSIRE. Washington Incentives/Policies for Renewable Energy. Renewable Energy Cost Recovery Incentive Payment Program. Accessed September 2013 at:

http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=WA27F

⁴⁰⁵ Washington State Legislature. WAC 458-20-273. Renewable energy system cost recovery. Accessed September 2013 at: <http://apps.leg.wa.gov/wac/default.aspx?cite=458-20-273>

not exceed 75 kW and tax incentives are limited to single customers that may not receive more than \$5,000 per project per /year.⁴⁰⁶

In 2009, Washington passed SB 6170 qualifying community solar projects up to 75 kilowatts (kW) to receive the production incentive. The production incentives range from \$0.30/kWh to \$1.08/kWh and are capped at \$5,000 per year. SB 6170 also increased the tax credit that utilities may claim for awarding production incentives from a limit of \$25,000 or 0.25 percent of a utility's taxable power sales (whichever is greater) to \$100,000 or 0.5 percent of a utility's taxable power sales.⁴⁰⁷ The incentives apply to power generated as of July 1, 2005, and remain in effect through June 30, 2020.⁴⁰⁸

While Washington has no limitations on the generating capacity of eligible cost-recovery systems (with the exception of limiting community solar projects to a generating capacity of 75 kW), payment caps limit the size of eligible systems.

Since 2006, the average annual growth of renewable energy systems certified under WAC 458-20-273 over the previous year has been about 49 percent, with the highest growth rate in renewable energy systems being fiscal 2007 (135.3 percent) after the program's inception followed by fiscal year 2013 at 73.6 percent.⁴⁰⁹ Since 2006, a total of 4202 renewable energy systems (19.6 MW) of renewables have been approved; with 4022 PV systems (18,522 kW), 125 wind systems (582 kW) and one digester (450 kW).⁴¹⁰

A key difference between the Washington tax incentive mechanism and a true FiT is that the tax incentive is offered as a supplemental payment instead of an actual purchase of the renewable generation. The renewable generation in almost all cases is consumed by the project owner through a net metering arrangement with the utility. Owners effectively are paid at the utility's retail electric rate, which varies across Washington utilities from 3 cents/kWh to more than 10 cents/kWh. If the utility purchases the generation through a purchased power agreement (PPA), the tax incentives are paid in addition to the rate established in the PPA.

⁴⁰⁶ Energy Information Administration. Electricity Feed-In Tariffs and similar programs. State Policies as of May 2013. Accessed September 2013 at: http://www.eia.gov/electricity/policies/provider_programs.cfm

⁴⁰⁷ Department of Energy. Renewable Energy Cost Recovery Incentive Payment Program. Accessed September 2013 at: <http://energy.gov/savings/renewable-energy-cost-recovery-incentive-payment-program>

⁴⁰⁸ DSIRE. Washington Incentives/Policies for Renewable Energy. Renewable Energy Cost Recovery Incentive Payment Program. Accessed September 2013 at:

http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=WA27F

⁴⁰⁹ Washington State Department of Revenue. *Growth from Renewable Energy Cost Recovery Program*. (August 2013). Accessed September 2013 at:

<http://dor.wa.gov/Docs/Pubs/Incentives/RenewableEnergyProgramProgress.pdf>

⁴¹⁰ Washington State Department of Revenue. *Growth from Renewable Energy Cost Recovery Program*. (August 2013).

13.1.1 Literature Review of Washington Potential

Replacing Washington's existing combination of net metering and a tax incentive mechanism with an actual FIT could help accelerate the deployment of renewable energy sources, reduce GHG emissions as well as achieve other important economic development and social goals. Accelerating the deployment of renewable energy sources through FITs could ease the transition from undesirable, more carbon intensive electricity generation energy sources, such as coal-fired power plants, to more desirable electricity generation sources, such as wind and solar.

The main attraction of the FIT is that it has shown high success in different economic and legal contexts in other countries for quickly driving the production of renewable energy by providing a guaranteed return for developers and reducing the red tape associated with connecting renewable energy systems to the grid. However, because the program is supported by ratepayers, electricity rates will likely increase as they have in Europe, though the impact of a FIT may vary significantly across the U.S. and other jurisdictions.⁴¹¹ Washington's renewable tax incentive FIT policy mechanism is borne by taxpayers rather than ratepayers, through tax credits. The cost of the Renewable Energy Cost Recovery Program has grown from \$52,729 in fiscal year 2007 with 10 utilities participating in the program, to \$1,155,125 in fiscal year 2012 with 32 utilities participating in the program.⁴¹²

Typically, the economic impact of a FIT will likely vary by ratepayer class; notably residential, commercial and industrial customers. To the extent the FIT represents an 'above market cost' the FIT increases the cost of electricity to households and businesses. In 2009, the Division of Energy Planning within the Vermont Department of Public Service evaluated the economic impacts of Vermont FIT and found that for households, the economic impact is largely through an income effect whereby households reduce expenditures on 'all other' items to pay for a rising electric bill. Similarly, the productive sectors of the economy, industrial and commercial ratepayers are faced with limited options as well. They will pay higher electric bills which raise their cost of production and may leave them disadvantaged relative to out-of-state competition. When the composite price falls below the forecasted market price, the cost of electricity to homes and businesses will decrease relative to what it would have been. For those years where FIT fall below market costs the opposite effects would occur whereby households and businesses benefit from lower energy bills.⁴¹³ A 2010 DOE study found that while electricity rates may increase, the resulting growth in the renewable energy market may also stimulate the State economy by creating jobs to

⁴¹¹ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

⁴¹² Washington State Department of Revenue. Growth from Renewable Energy Cost Recovery Program. (August 2013).

⁴¹³ Vermont Department of Public Service, Division of Energy Planning. *The Economic Impacts of Vermont Feed in Tariffs*. December 2009. Report accessed August 2013 at <http://www.renewwisconsin.org/policy/ARTS/MISC%20Docs/DPS%20White%20Paper%20Feed-in%20Tariff.pdf>

site, develop, and build the renewable energy systems. This is especially true during the construction phase of capital-intensive renewable projects.⁴¹⁴

While the California and Vermont FITs differ; notably in terms of 1) overall program cap, with California's FIT capping at 500 MW and Vermont's FIT capping at 50 MW; and 2) payment structure, with California's payments based on avoided costs in contrast to Vermont's FIT payments based on cost of generation and profit. Despite their differences, studies evaluating their economic impacts may provide some insight into potential impacts for Washington State.

In a 2010 study, the Energy and Resources Group at the University of California estimated that the FIT enacted by the Renewable Energy and Economic Stimulus Act (REESA) would have a range of economic benefits to the state of California; notably that the FIT would:⁴¹⁵

- Create three times the number of jobs from 2011-2020. This equates to generating about 280,000 additional direct job-years or 28,000 job-years on average per year from 2011-2020 with an additional 27,000 indirect and induced jobs per year. More jobs are generated in the first part of the decade than in later years.
- Increase direct state revenues by an estimated \$1.7 billion from sales tax, use tax, and income taxes over the next decade and estimated induced revenues of about \$600 million from increased employee compensation and the impact of FIT program costs. This does not include any savings to the state in avoided unemployment benefits.
- Stimulate up to \$50 billion in total new investment in the state which in turn is eligible for up to \$15 billion in Federal tax benefits for project developers.

The study concluded that the REESA FIT provides a highly cost-effective avenue to assist in the state's efforts to achieve the 33 percent Renewable Portfolio Standard (RPS) target by 2020. The California study corresponds with key findings and results from Ontario's FIT program, in that it increased the amount of clean energy in Ontario's supply mix, created 31,000 direct and indirect clean energy jobs, and attracted over \$20 billion in private sector investment to Ontario during challenging economic times.⁴¹⁶

The 2010 California study found that increased investments in renewable energy deployment may lead to higher employment upfront from the construction, installation and manufacturing sectors. This surge in employment, however, may be counteracted to a certain degree by

⁴¹⁴ NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

⁴¹⁵ Renewable and Appropriate Energy Laboratory, Energy and Resources Group, University of California, Berkeley (University of California, Berkeley). *Economic Benefits of a Comprehensive Feed-In Tariff: An Analysis of the REESA in California*. July 2010. Report accessed August 2013 at <http://rael.berkeley.edu/sites/default/files/Kammen,%20FIT%20Study.pdf>

⁴¹⁶ Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

ratepayers having to pay higher electricity bills initially and having a lower level of disposable income, resulting in less employment from consumer spending.⁴¹⁷ Similarly, the 2009 Vermont study found that initial capital investments as a result of the FIT were expected to provide a temporary boost to employment (especially construction and related trades) and personal incomes across Vermont. The study estimated the impacts to quickly diminish as projects are completed, with some minor positive job and income effects in following years from indirect spending resulting from higher incomes in sectors that service and support project build out.⁴¹⁸

While data on US FIT programs is not readily available, a 2010 study by World Future Council assessed the success of FIT in North America based on set criteria, including program caps, project size, contract terms and number of technologies included. The Vermont program earned a score of 54/100 largely because the program is limited to only 50 MW, or about 2 percent of existing generation. California scored a 28/100 largely due to its one size fits all policy with a tariff based on avoided cost. In addition, California's feed in tariff was found to have a very low program cap, a low project size cap and tariffs that vary by time of day.⁴¹⁹ In comparison, the study found that Ontario's FIT to be the most progressive in North America and scored an 84/100. The program awarded nearly 80MW of contracts to homeowners for rooftop solar PV and about 2,500 MW of contracts for wind, solar, biogas and hydro projects, 20 percent off which were awarded to homeowners, farmers, community and aboriginal groups.⁴²⁰

Expanding the FIT program in Washington could help enhance and accelerate the deployment of renewable energy sources while also supporting other policy goals, such as GHG reduction and creation of clean energy jobs. Designing a FIT compatible with existing policies and economic goals will be critical for policy efficacy and success. The payment schedule is critical to sending the appropriate signals to investors as are subsequent policies, standards and procedures to facilitate the deployment of renewable energy once contracts are in place. Key elements of a successful FIT include: 1) contract length, with longer-term contracts providing a stable policy environment; 2) interconnection rules and agreements, with streamlined processes allowing energy generators to connect to the grid and ensuring that renewable resources are able to contribute to the power mix; 3) program and project caps; while program caps limit the potential for renewable energy projects, program caps can serve to moderate the potential cost to ratepayers and system integration impacts of introducing a large number of FIT-funded renewable resources and project caps can serve to moderate the number of large projects and/or

⁴¹⁷ University of California, Berkeley. *Economic Benefits of a Comprehensive Feed-In Tariff: An Analysis of the REESA in California*. July 2010.

⁴¹⁸ Vermont Department of Public Service, Division of Energy Planning. *The Economic Impacts of Vermont Feed in Tariffs*. December 2009.

⁴¹⁹ Institute for Self Reliance. *Feed-in tariffs in America Driving the Economy with Renewable Energy Policy that Works*. April 2009

⁴²⁰ The World Future Council. *Grading North American Feed-in Tariffs*. May 2010.

broaden the type of technologies; 4) while tariff revisions may ensure probability and program sustainability, they should be clearly communicated to investors to maintain a stable policy environment; 5) payment differentiation can incentivize certain technologies, resource type or size of resource and 6) bonus payments can influence power producer behavior and promote efficiencies and policy priorities such as using locally sourced materials.⁴²¹

13.2 Quantification

This section provides a simplified estimate of the GHG reductions that can be expected for Washington State from the implementation of a feed-in-tariff program (FIT). FIT programs vary in both size and structure. Some programs are geared to small distributed renewable generation projects, such as California's which originally set a qualifying capacity limit of 1.5 MW, but has since increased that limit to 3 MW. Others limit the total generation capacity that is eligible for participation in the program (Vermont's FIT is limited to only 50 MW cumulatively) whereas others such as Ontario's FIT program, don't limit either the capacity of an individual project or the total capacity eligible for the program. Because of the variation in program specifications, this reduction quantification methodology targeted the development of a reduction factor per MWh of generation added through the program. This can be combined with estimates of generation using different program design parameters and assumptions. The calculated reduction factor for a FIT program was 0.867 Metric Tons CO_{2e} per MWh of renewable generation.

Many existing FIT policies set "caps" on capacity both for individual projects and for the overall program. The individual project caps (3 MW in California), are designed to ensure the program is only utilized by customer-owned and other small scale renewable projects. The capacity cap for the overall program is put in place to limit the maximum participation and constrain total costs. Existing FIT programs in California and Germany have adjusted these caps as the programs evolve to increase participation and expand the impacts of the programs.

It is also important to note that any FIT program in Washington may not generate significant additional reductions beyond what is already expected through the Renewable Portfolio Standard as part of I-937, but instead could be a mechanism through which utilities can meet a portion of their RPS targets. California's FIT program attempts to use their FIT in this way as the policy states the intent is *"to encourage electrical generation from small distributed generation that qualifies as "eligible renewable energy resources" under the RPS Program."*⁴²² However, this depends on the policy design in Washington and whether or not customer-owned renewable generation through the FIT program may be counted towards the RPS target, or whether the RPS targets may be increased in recognition of utilities ability to capture the FIT eligible renewable

⁴²¹ NARUC. Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions. June 2010.

⁴²² http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/167679.pdf, page 3.

sources. In either case the reduction factor provided in this estimate will enhance the understanding of any FIT program's contribution to the overall reductions provided by increased renewable generation.

13.2.1 Methodology

Because a FIT program in Washington would be a complementary to the RPS, the methodology to calculate a reduction factor was done in the context of I-937. The reductions from the RPS component of I-937 were calculated by forecasting emissions from a business as usual (BAU) baseline that had no set renewable requirements using DOE and Regional fuel mix forecasts. The BAU was then compared to a policy emission forecast that set renewable targets. The policy scenario applied assumptions on the fuel mix of displaced generation in order to estimate how much existing fossil energy would be replaced with renewables under the RPS.

As the specific design parameters for a FIT in Washington are unclear, this analysis provides a reduction factor to illustrate how a FIT might contribute to meeting I-937 goals. This was done by performing a sensitivity analysis on the modeled reductions from I-937, by adjusting the level of renewable consumption in each of the target years to determine what the incremental reductions were for every added MWh of renewable generation. The specifics of the I-937 methodology that was the basis of this calculation can be referenced in the previous analysis *Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State*. This analysis assumes a constant fuel mix for added fossil generation in the baseline forecast, and a constant fuel mix for displaced fossil generation in the policy forecast. Therefore, the reduction factor is constant through 2030, despite year to year variability. This analysis is only applicable through 2030 because fuel mix and load growth forecasts are only available and valid in that timeframe, with uncertainty growing too large beyond 2030 to create viable estimates. However, the reduction factor could be applied in future years to get an order of magnitude estimate of potential reductions (hundreds, thousands, or millions of tons).

The calculated reduction factor was applied to a total of three scenarios using different tariff levels. The results can be linearly scaled at different capacity caps, for example if the program capacity cap were doubled, the costs and reductions as calculated here would double as well, assuming the cap was reached in both scenarios. For the purposes of this analysis only one capacity cap was chosen and then examined at different tariff levels. Washington State has roughly half the electricity generation of California, so the capacity cap chosen for the analysis was 375 MW, half of the current California cap of 750 MW of eligible capacity. The three cost scenarios are based on the low, median, and high incentives currently provided by Washington State's tax incentive program of \$0.12, \$0.33, and \$0.54 per kWh. Costs are determined by subtracting out the alternative cost of electricity using California's FIT 2011 price referents which are based on the predicted annual average cost of production for a combined-cycle natural gas (NGCC) fired baseload proxy plant, of \$0.091 per kWh

13.2.2 Assumptions, Exclusions, and Data Sources

The following assumptions were used in estimating the GHG reduction factor for renewable generation associated with a FIT program in the state of Washington.

- The FIT program would be a complementary program to the RPS
- Assumed the program cap of 375 MW of eligible capacity is reached within 3 years.
- Assumed project size cap at 3 MW (up from the current tax incentive programs limit of 75 kW, which should allow the 375 MW capacity to be reached in 3 years with greater diversity in project types, not just rooftop solar.
- The U.S. Average generation of 3,320 MWh per MW of installed Renewable Capacity⁴²³ is dominated by utility scale wind and hydro, current solar projects under the Washington 2005 tax incentive are averaging 1,000 MWh per MW⁴²⁴, however with the assumed increase in the project capacity cap, it is expected more diversity and greater generation as project scales increase. A value of 1500 MWh per MW was used for this analysis.
- Each incremental MWh of renewable generation results in 0.867 Metric Tons of GHG reductions.
- Alternative cost of electricity generation of \$0.091/kWh is based on CA 2011 market price referents. No time of day adjustments made and contract signings are assumed to be evenly distributed in 2013, 2014 and 2015, and assumed contract length of 15 years.⁴²⁵
- Tariff price per kWh is based on the low, median, and high price of the range of incentives currently paid under Washington's 2005 fixed price tax incentive program. The mid-level tariff rate of \$0.33/kWh is relatively similar to the assumed cost of installed solar, and can be representative of a tariff level targeted to the cost of solar.

Figure 11: Constant Fuel Mix for Displaced Fossil Generation

Fuel Source	Percent of Displaced Generation from Increased Renewables
Hydro	0.00%
Coal	74.70%
Cogen	0.00%
NG	25.00%
Nuclear	0.00%
Petroleum	0.30%
Landfill Gases	0.00%

Based on Washington CAT ES Policy Option Analysis 2007, p 47:
http://www.ecy.wa.gov/climatechange/interimreport/122107_TWG_es.pdf

⁴²³ <http://www.eia.gov/renewable/state/>

⁴²⁴ Glenn Blackmon – WA Government

⁴²⁵ <http://www.cpuc.ca.gov/PUC/energy/Renewables/Feed-in+Tariff+Price.htm>

13.2.3 Results

The result of the analysis to determine a reduction factor, reductions, and costs associated with the FIT program under different scenarios are provided in the table below. The reduction factor was calculated to be 0.867 metric tons CO₂e avoided per MWh of renewable generation. This value can be applied to other scenarios using alternative assumptions on program design to further examine FIT programs in Washington.

Table 64. Potential GHG reductions, FIT payments, and renewable generation from FIT implementation.

Scenario 375 MW Capacity Cap	\$0.12 / kWh		\$0.33 / kWh		\$0.54 / kWh	
Total Annual Generation (MWh)	1,207,632		1,207,632		1,207,632	
Reduction Factor	0.867		0.867		0.867	
Total Reductions (MMTCO ₂ e)	0.5		0.5		0.5	
% of 2020 Renewable Generation % 2020 Total Generation from FIT Sources	6%	1%	6%	1%	6%	1%
FIT Incentive Cost of Alternative (\$/ kWh)	\$0.12	\$0.091	0.33	\$0.091	\$0.54	\$0.091
Annual Tariff Cost Annual Cost of Production (Million \$)	67.5	64.1	185.6	64.1	303.8	64.1
Net Incentive (Million \$)	3.4		121.5		239.6	
Cost of Alternative - NGCC (Million \$)	51.5		51.5		51.5	
Net Cost (Million \$)	16.0		134.2		252.3	
Cost per Metric Ton of Reductions	\$32.91		\$275.16		\$517.41	

13.3 Implementation History

FITs are used to a limited extent around the United States, but they are more common internationally. Historically, FITs have been associated with a German model in which the government mandates that utilities enter into long-term contracts with generators at specified rates, typically well above the retail price of electricity. In the United States, where FITs are comparatively new, FITs or similarly structured programs are mandated to varying degrees in a limited number of states. However, a different model has also emerged in which utilities independently establish a utility-level FIT, either voluntarily or in response to state or local

government mandates.⁴²⁶ This section reviews FIT programs in Germany, Ontario, and California.

Germany

The Renewable Energy Sources Act, also known as EEG (Erneuerbare-Energien-Gesetz) law, has enabled renewable energy investments in large scale throughout Germany through the use of FITs. In 2011, the FIT program rates were significantly enhanced as part of a government policy, called “Energiewende”, to accelerate the phase out of eight nuclear plants totaling 20.9 GW of electric power generation capacity. Amendments in 2012 increased the term of the FIT guaranteed rate from 15 years to 20 years for some installations, designed to spur new projects and investments in Germany, particularly smaller ones. FIT rates vary based on source fuels, such as hydropower, land fill gas, sewage gas, mine gas, biomass (bio waste and small manure biogas), geothermal, on-shore wind, off-shore wind, and solar. There is also a lower tariff provided for self-consumption at certain sites.

Germany has established fixed FIT rates for 2012 to 2021, providing clear long term investment protection and guidance for developers, though these rates fluctuate based on technology, installation size, and are based on levelized project costs. With the new amended and enhanced rates, Solar Photovoltaic (PV) has become a very attractive technology. Renewable energy accounted for total investment of €22.9 Billion in 2011, with PVs accounting for €15.0 Billion. The total economic output of German based renewable energy manufactures and installers was €24.94 Billion, including exports.

By 2020, the goal is to have 14 percent of total energy sourced from renewables, which will be achieved by using renewables to provide 35 percent of electricity, 18 percent of thermal energy and 10 percent in transportation sector, leading to a 40 percent reduction in GHGs when compared to 1990 standards. The renewable energy source goals increase incrementally each decade thereafter until 2050 when renewables are expected to provide 80 percent of the electricity, 60 percent of thermal energy. With 25 percent reduction through efficiency, the overall reduction in GHG is anticipated to be 80 percent to 95 percent by 2050.

Ontario

In early 2009, the Green Energy & Green Economy Act passed, establishing Ontario’s FIT program designed to create new clean energy industries and jobs, boost economic activity and the development of renewable energy technologies, and improve air quality by phasing out coal-fired electricity generation by 2014.⁴²⁷ Qualifying renewable technologies include biogas,

⁴²⁶ EIA. May 2013. Feed-in tariff: A policy tool encouraging deployment of renewable electricity technologies. Accessed August 2013 at: <http://www.eia.gov/todayinenergy/detail.cfm?id=11471>

⁴²⁷ Ontario Ministry of Energy. Feed-In Tariff Program Two-Year Review. Accessed September 2013 at: <http://www.energy.gov.on.ca/en/fit-and-microfit-program/2-year-fit-review/>

renewable biomass, landfill gas, solar photovoltaic (PV), hydro power and wind power.⁴²⁸ The Ontario Power Authority (OPA) is responsible for implementing the FIT Program. Within two years OPA signed about 2,000 small and large FIT contracts with clean energy producers totaling approximately 4,600 MW.⁴²⁹ Ontario's FIT program has played a significant role in jumpstarting renewable energy, ranking #4 and #11 in North America for solar and wind deployment. It has also enabled widespread participation in renewable energy generation with 1 in 7 Ontario farmers participating and earning a return on their investment.⁴³⁰

FIT Program has been key to making Ontario a leader in clean energy production and manufacturing. FIT attracted more than \$20 billion in private sector investment to Ontario during challenging economic times, welcomed more than 30 clean energy companies to the province as of 2011⁴³¹ and created more than 31,000 jobs as of 2013.⁴³² By the end of 2014, Ontario will be the first jurisdiction in North America to replace coal-fired generation with cleaner sources of power.⁴³³ Ontario has shut down 10 of 19 coal units and reduced the use of coal by nearly 90 per cent since 2003.⁴³⁴ Moreover, Ontario is on track to procure 10,700 MW of non-hydro renewable energy generation by 2015.⁴³⁵ To support the long-term sustainability of the FIT Program, OPA has set annual procurement targets of 150 megawatts for small FIT and 50 megawatts for microFIT for each of the next four years, beginning in 2014.

The biggest challenge for the FIT program is the overwhelming demand. Signed contracts for nearly 5,000 megawatts of new renewable energy capacity will allow the province to meet most of its 2030 renewable energy target, 12 years early.⁴³⁶ While Ontario's FIT program has

⁴²⁸ Ontario Power Authority. Feed-In Tariff (FIT) Program, FAQs. Accessed August 12, 2013.

<http://fit.powerauthority.on.ca/faqs>

⁴²⁹ Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report*. March 2012. <http://www.energy.gov.on.ca/docs/en/FIT-Review-Report-en.pdf>

⁴³⁰ Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

⁴³¹ Ontario Ministry of Energy. Feed-In Tariff Program Two-Year Review. Accessed September 2013 at:

<http://www.energy.gov.on.ca/en/fit-and-microfit-program/2-year-fit-review/>

⁴³² Energy Manager Today. Ontario's Buy Local Feed-In Tariff Stuck In A Rut After Initial Success. May 20, 2013. Accessed September 2013 at: <http://www.energymanagertoday.com/ontarios-buy-local-feed-in-tariff-stuck-in-a-rut-after-initial-success-092031/>

⁴³³ Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report*. March 2012.

⁴³⁴ Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report*. March 2012.

⁴³⁵ Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report*. March 2012.

⁴³⁶ Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

stumbled with less than 10 percent of its contracted capacity deployed, it remains competitive with leading U.S. states.⁴³⁷

California

On February 14, 2008, the California Public Utilities Commission (CPUC) authorized the purchase of up to 480 MW of renewable generating capacity from renewable facilities smaller than 1.5 MW. The FIT provides a mechanism for small renewable generators to sell power to the utility at predefined terms and conditions, without contract negotiations, setting the price paid to small generators at the level of the Market Price Referent (MPR). In 2009, eligible project size was increased to 3 MW.⁴³⁸ The original FIT program closed on July 24, 2013, and was replaced by a renewable market adjusting tariff (ReMAT).

In May 2012, the CPUC implemented a new pricing mechanism and program rules for the FIT program, the ReMAT, in response to stakeholders' petitions for modification.⁴³⁹ The ReMAT allows the FIT price to adjust in real-time based on market conditions. ReMAT is being implemented by IOUs to comply with the IOU's portion of the 750 MW state-wide feed-in tariff program mandated by SB 32.⁴⁴⁰ ReMAT includes two principle components: First, the starting price increases or decreases for each product type based on the market's participation in the program and applies to three FIT product types (ie.i.e. baseload, peaking as-available, and non-peaking as-available). Second, a two-month price adjustment mechanism may increase or decrease the price for each product type every two months based on the market response. The IOU-share of MWs under the revised FIT program is 493.6 MW.⁴⁴¹

⁴³⁷ Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

⁴³⁸ California Public Utilities Commission. *Feed-in Tariffs Legislative History*. Accessed August 2013 at: http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/fit_legislativeHistory.htm

⁴³⁹ WSGR. *California Public Utilities Commission Adopts Terms of Standard FIT Contract and Revised Tariffs*. June 2013. Article access August 2013 at <http://www.wsg.com/WSGR/Display.aspx?SectionName=publications/PDFSearch/wsgalert-standard-FIT-contract.htm>

⁴⁴⁰ PG&E. Renewable Market Adjusting Tariff (ReMAT) Feed-In Tariff (FIT). Program Overview. (PowerPoint Presentation). Accessed September 2013 at: http://www.pge.com/includes/docs/pdfs/b2b/energysupply/wholesaleelectricssuppliersolicitation/standardcontractsforpurchase/ReMAT_Webinar1_Overview.pdf

⁴⁴¹ WSGR. *California Public Utilities Commission Adopts Terms of Standard FIT Contract and Revised Tariffs*. June 2013.

14 Commercialization of Offshore Wind and Ocean Energy

Table 65: Potential Costs and Benefits and Additional Screening Criteria for Commercialization of Off-Shore Energy to Washington Consumers and Businesses

Potential Action for Consideration	
<ul style="list-style-type: none"> A policy, or set of policies, designed to support the commercialization of ocean energy in Washington could help enhance and accelerate the deployment of off-shore energy sources while also supporting other policy goals, such as GHG reduction and creation of clean energy jobs. 	
Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
<ul style="list-style-type: none"> As offshore energy is still in the research and development phase, potential impacts to consumers are still undetermined. 	<ul style="list-style-type: none"> As offshore energy is still in the research and development phase, potential impacts to businesses are still undetermined.
Summary of Screening Criteria	
<p><i>Does the policy target an emissions source of significant magnitude in Washington?</i></p> <p>Yes, once deployed offshore energy has the potential to replace an emission source of significant magnitude in Washington. In 2010, the electricity sector accounted for 21.5 percent of statewide GHG emissions, emitting 20.7 MMTCO_{2e}.⁴⁴² With offshore winds blowing harder and more uniformly than on land, NREL finds that the Pacific Northwest has about 342 GW of gross offshore wind resource, with 15.1 GW in shallow waters (0-30 meters in depth), 21.3 GW at transitional waters (30-60 meters in depth) and 305.3 GW in deep waters (more than 60 meters in depth), though these gross resource values will likely shrink by 60 percent or more after all environmental and socioeconomic constraints are taken into account.⁴⁴³ A DOE study, published in August 2012, found that 7.5 percent of Washington State's annual load could be met with wave energy by 2030, and 36 percent of the load by 2050, assuming 80 percent cost reduction is achieved, and at 70 percent deployment density.⁴⁴⁴</p> <p><i>What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?</i></p> <p>DOE is engaged in several ongoing offshore wind activities and invested a total of \$708,133 for offshore wind technology development in Washington State from 2006-2012⁴⁴⁵ and is expected to award about \$50 Million to the WindFloat Pacific Project from February 2013 through December 2017 for full project implementation of a 30 MW offshore wind demonstration project.⁴⁴⁶ NREL estimates a current baseline</p>	

⁴⁴² Washington State Department of Ecology. *Washington State Greenhouse Gas Emissions Inventory 2009-2010*. December 2012. Report accessed August 2013 at <https://fortress.wa.gov/ecy/publications/publications/1202034.pdf>

⁴⁴³ National Renewable Energy Laboratory (NREL). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (September 2010). Accessed September 2013 at <http://www.nrel.gov/wind/pdfs/40745.pdf>

⁴⁴⁴ Previsic, M. The Future Potential of Wave Power in the United States. U.S. DOE EERE. August 2012. Accessed August 2013 at: <http://www.oregonwave.org/wp-content/uploads/The-Future-of-Wave-Power-MP-9-20-12-V2.pdf>

⁴⁴⁵ US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Offshore Wind Projects. Fiscal Years 2006-2012*. (December 2012) Accessed September 2013 at http://www1.eere.energy.gov/wind/pdfs/offshore_energy_projects.pdf

⁴⁴⁶ <http://pnwer.org/Portals/26/Sen%20Roblan%20-%20Principle%20Power%20and%20the%20Wind%20Float%20Pacific%20Project.pdf>

of installed capital costs for offshore wind at \$4,250 per kilowatt (kW) based on energy market surveys.⁴⁴⁷ As other types of offshore energy are still in the research and development phase, volume and cost of GHG reductions is still undetermined. Nonetheless, the DOE Water Power Program finds ocean energy has realized significant returns on the federal investment to date and anticipates significant key accomplishments in the years to come.^{448,449} A 2012 DOE study estimated wave technology costs to be about \$4,347/kW of capital costs and about \$163/kW annual operations and maintenance costs.⁴⁵⁰ A study by the International Energy Agency estimated the investment cost of wave power at between \$6,800 and \$9,000/kW, but expects it to be reduced to \$5,700/kW by 2020 and to \$4,700/kW by 2030 as a result of technology learning and larger deployment. The EIA also estimated the cost of tidal stream power in 2010 between \$6,000 and \$7,800/kW (US\$ 2008), and projected it to decline to \$5,000/kW by 2020, and to \$4,100/kW by 2030.⁴⁵¹ The European Commission estimates that wave energy could avoid 1.0 – 3.3 mtCO₂e/year in Europe by 2020. The corresponding maximum cumulative avoided CO₂e emission for the period 2010 to 2030 could be up to 275 Mt CO₂e.⁴⁵²

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

Commercialization of offshore energy could be designed as a discrete and comprehensive policy targeting the advancement and deployment of specific offshore energy technologies or could be part of a bundle of related policies targeting innovation, research and development, advancement of new technologies as well as attracting private sector investments and clean energy companies in Washington.

Can the policy be meaningfully implemented or influenced at the State level?

Yes. Depending on program design, commercialization of offshore energy could be meaningfully implemented or influenced at the state level to achieve policy goals beyond GHG emissions reductions, such as economic development and social policy goals.

14.1 Introduction

Although Washington's GHG emissions from the electricity sector are small relative to the contribution of this sector in other states, in absolute terms they represent 20.7 MMTCO₂e, or 21.5 percent of statewide emissions. Washington has recognized the potential to reduce these emissions through further implementation of clean, renewable energy sources, such as offshore energy. In November 2011 the Washington Ocean Energy Conference was held in Bremerton,

⁴⁴⁷ EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*. (February 2011.) Accessed September 2013 at

⁴⁴⁸ US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012*. (January 2013) Accessed August 2013 at http://www1.eere.energy.gov/water/pdfs/wp_accomplishments_brochure.pdf

⁴⁴⁹ DOE EERE Water Power Program website accessed August 2013 at <http://www1.eere.energy.gov/water>.

⁴⁵⁰ Previsic, M. The Future Potential of Wave Power in the United States. U.S. DOE EERE. August 2012. Accessed August 2013 at: <http://www.oregonwave.org/wp-content/uploads/The-Future-of-Wave-Power-MP-9-20-12-V2.pdf>

⁴⁵¹ Energy Technology Systems Analysis Programme. Marine Energy. Accessed August 2013 at: http://www.iea-etsap.org/web/E-TechDS/PDF/E08-Ocean%20Energy_GSgct_Ana_LCPL_rev30Nov2010.pdf

⁴⁵² EU Strategic Energy Technologies Information System. Ocean wave energy: Technology Information Sheet. Accessed August 2013 at: <http://setis.ec.europa.eu/publications/technology-information-sheets/ocean-wave-energy-technology-information-sheet>

WA, producing a high level of interest and enthusiasm for a multi-stakeholder effort focused on the challenges and opportunities of ocean energy off the Washington Coast.⁴⁵³ The vast ocean energy resource in Northwest waters was noted as having potential advantages in a number of respects, including considerable economies of scale for offshore installations, reduced environmental impacts, and proximity to population centers.⁴⁵⁴ Governor Gregoire's interest in the potential of ocean energy and related economic opportunities associated with development of related technologies was also conveyed at the conference, pointing out the need for tax and other incentives.⁴⁵⁵

Offshore winds tend to blow harder and more uniformly than on land, providing the potential for increased electricity generation and smoother, steadier operation than land-based wind power systems.⁴⁵⁶ A 2010 NREL study found that the Pacific Northwest has about 342 GW of gross offshore wind resource, with 15.1 GW in shallow waters (0-30 meters in depth), 21.3 GW at transitional waters (30-60 meters in depth) and 305.3 GW in deep waters (more than 60 meters in depth). This wind mapping effort, however, does not currently account for a range of siting restrictions and public concerns. These gross resource values will likely shrink by 60% or more after all environmental and socioeconomic constraints have been taken into account.⁴⁵⁷

The opportunities for advancing offshore wind technologies are accompanied by significant technology challenges as offshore wind technologies are still in the very early stages of development. Moreover, offshore wind installations have higher capital costs than land-based installations per unit of generating capacity, largely because of turbine upgrades required for operation at sea and increased costs related to turbine foundations, balance-of-system infrastructure, interconnection, and installation. NREL estimates a current baseline of installed capital costs for offshore wind at \$4,250 per kilowatt (kW) based on energy market surveys.⁴⁵⁸ Nonetheless, NREL finds that high electricity costs in coastal regions, more energetic wind regimes offshore, and close proximity of offshore wind resources to major electricity demand centers could allow offshore wind to compete relatively quickly with fossil fuel-based electricity

⁴⁵³ Clean Tech West Sound website accessed August 2013 at <http://ctwsound.com/events/>

⁴⁵⁴ Clean Tech West Sound. *Washington State Ocean Energy Conference*. (2011) http://ctwsound.com/wp-content/uploads/2012/07/WSOEC_SummaryofSpeakersRemarks_2011.pdf

⁴⁵⁵ Clean Tech West Sound. *Washington State Ocean Energy Conference*. (2011)

⁴⁵⁶ NREL. *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (September 2010).

⁴⁵⁷ NREL. *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (September 2010).

⁴⁵⁸ EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*. (February 2011.) Accessed September 2013 at http://www1.eere.energy.gov/wind/pdfs/national_offshore_wind_strategy.pdf

generation in many coastal areas.⁴⁵⁹ While the opportunities for offshore wind are abundant, the technical, infrastructure and permitting barriers and challenges remain significant.⁴⁶⁰

Ocean energy involves the generation of electricity from waves, tides, currents, the salinity gradient, and the thermal gradient of the sea, with wave and tidal energy currently being the most mature technologies. Various wave and tidal energy systems have been deployed in several countries, and these technologies are making the transition from research to demonstration projects to market penetration. Though ocean energy is not yet competitive with more mature renewable energy technologies such as wind, it has the potential to be highly predictable as compared with other renewable generation assets, enhancing its value to the utility industry and its customers.

With ocean energy offering the potential for long-term carbon emissions reduction, government policies are contributing to accelerating the development and deployment of ocean energy technologies. The global marine energy resource exploitable with today's technology is estimated to be about 140 – 750 TWh/year, rising to 2,000 TWh/year or 13 percent of world electricity consumption (which is about 15,400 TWh/year).⁴⁶¹ The DOE estimates the total available U.S. wave energy resource to be at 2,640 TWh/yr, with Alaska containing the largest number of locations with high kinetic power density, followed by other coastal states, including Washington, Oregon and California.⁴⁶²

Policy instruments to promote ocean energy technologies in the U.S. entail research and development programs and grants, national research and testing facilities, and permitting regimes in the outer continental shelf. At the national level, the Department of Energy's (DOE) Water Power Program aims to accelerate the technological development and deployment of innovative water power technologies capable of generating electricity from water, such as hydropower, wave, tidal, and current devices, by funding research and development activities through competitive solicitations. The DOE finds that there is a vast amount of energy available in ocean waves and tides and estimates the total available U.S. wave energy resource to be at 2,640 TWh/yr. Given the limits of device arrays, approximately 1,170 TWh/ yr of the total resource is

⁴⁵⁹ EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*. (February 2011.)

⁴⁶⁰ NREL. *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (September 2010).

⁴⁶¹ EU Strategic Energy Technologies Information System. *Ocean wave energy: Technology Information Sheet*. Accessed August 2013 at: <http://setis.ec.europa.eu/publications/technology-information-sheets/ocean-wave-energy-technology-information-sheet>

⁴⁶² US Department of Energy, Energy Efficiency and Renewable Energy (DOE EERE) Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012*. (January 2013)

theoretically recoverable, with 250 TWh/yr for the West Coast.⁴⁶³ The DOE therefore invests, supports and participates in programs, partnerships and projects across the country; including the Northwest National Marine Renewable Energy Center (NNMREC), the West Coast Governors Alliance (WCGA) and demonstration projects in Puget Sound, WA.

The NNMREC is a DOE funded partnership between the University of Washington and Oregon State University whose primary purpose is to support wave and tidal energy development for the United States. The DOE funds are matched at a 50 percent level by contributions from the University of Washington and the Center partners. This is to ensure that the Center is a true public-private partnership and strives to meet the needs of all marine energy stakeholders.⁴⁶⁴ NNMREC's mission is to facilitate the development of marine energy technology, inform regulatory and policy decisions, and to close key gaps in scientific understanding with a focus on student growth and development. More specifically, project objectives are to develop facilities to serve as integrated test Center for wave & tidal energy developers; evaluate potential environmental and ecosystem impacts; optimize devices and arrays; improve forecasting; and increase reliability and survivability.

As part of the West Coast Governors Alliance (WCGA) on Ocean Health, Washington, Oregon and California have agreed to collaborate with the Bureau of Ocean Energy Management (BOEM), DOE, Federal Energy Regulatory Commission (FERC), National Oceanographic and Atmospheric Administration (NOAA), and other agencies to evaluate the potential benefits and impacts of renewable ocean energy projects off the West Coast. An additional goal is to develop the planning and regulatory structure for these activities. The Renewable Ocean Energy Action Coordination Team is charged with exploring the feasibility for offshore alternative ocean energy development and evaluating the potential environmental impacts of these technologies.⁴⁶⁵ Washington has great ocean energy resources, with high tidal resources in the Puget Sound, WA. Having a clean, renewable, and predictable source of energy in the Puget Sound that could be connected directly into the shared local grid could provide many environmental, operational, and economic benefits.⁴⁶⁶

From 2008 through 2012, the DOE Water Power Program funded \$12,878,199 for marine and hydrokinetic energy programs and projects in Washington State. The Snohomish County Public

⁴⁶³ US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013)

⁴⁶⁴ Northwest National Marine Renewable Energy Center website accessed August 2013 at <http://depts.washington.edu/nnmrec/partners.html>

⁴⁶⁵ West Coast Governors Alliance on Ocean Health website accessed August 2013 at <http://www.westcoastoceans.org/index.cfm?content.display&pageID=110>

⁴⁶⁶ Snohomish County Public Utility District #1 website accessed August 2013 at <http://www.snopud.com/PowerSupply/tidal/tidalbg/tidalbgenergy.ashx?p=1509>

Utility District #1 (PUD) has received funding for tidal energy in-water testing and development in Puget Sound. The PUD is the second largest public utility in Washington, and is well positioned to share key learning among other regional and national stakeholders. NNMREC and the District have collaborated on multiple projects related to this effort, including site-characterization and development of monitoring capabilities. On March 1, 2012, the PUD filed a final license application with FERC for the Admiralty Inlet Pilot Tidal Project. This DOE-funded project represents approximately \$10 million of federal investment and will deploy two grid-connected 6 meter diameter turbines in Admiralty Inlet in 2013. The open-center turbines are ducted, horizontal axis tidal devices. Field measurements in this location are ongoing, making this the best characterized tidal site in the United States.⁴⁶⁷ In January 2013 FERC released a draft environmental assessment that found that placing two turbines in Admiralty Inlet would not harm the environment or nearby fiber-optic cables. While the owner of the fiber-optic cables disagrees with concerns about effects on killer whales and native plants, if all goes well for the Snohomish County PUD, the turbines could be in place in mid-2014.⁴⁶⁸

In addition, in March of 2011, Columbia Power Technologies' "SeaRay" wave energy converter was deployed in Puget Sound, WA. This 1:7 scale wave energy converter device was successfully tested over the course of one full year, being remotely controlled and operated from Corvallis, Oregon. This unique point absorber technology directly couples the motion of waves to the electrical generator via a direct drive, rotary power take-off. Capture of critical, in-water performance data will help inform the future designs of wave energy converters.⁴⁶⁹

Similarly, DOE is engaged in several ongoing offshore wind activities and has invested a total of \$93.4 million through the American Reinvestment and Recovery Act of 2009 (Recovery Act) into offshore-related activities within the Wind Program.⁴⁷⁰ From 2006 through 2012, the DOE Offshore Wind Program funded \$308,703,626, \$708,133 of which was allocated to Washington State for offshore wind technology development.⁴⁷¹ In addition, DOE is awarding \$4 Million to the WindFloat Pacific Project from February 2013 through February 2014 and is expected to award an

⁴⁶⁷ US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013)

⁴⁶⁸ Pacific Fishery Management Council. *Ocean Energy Notes* (January 29, 2013). Accessed August 2013 at <http://www.pcouncil.org/wp-content/uploads/Ocean-Energy-Notes.pdf>

⁴⁶⁹ US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013)

⁴⁷⁰ EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States.* (February 2011.) Accessed September 2013 at http://www1.eere.energy.gov/wind/pdfs/national_offshore_wind_strategy.pdf

⁴⁷¹ US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Offshore Wind Projects. Fiscal Years 2006-2012.* (December 2012).

additional \$47 Million from May 2014 through December 2017 for full project implementation of a 30 MW offshore wind demonstration project.⁴⁷²

14.2 Literature Review of Washington Potential

Policy mechanisms could help accelerate the deployment of wind and ocean energy, lead to the reduction of GHG emissions as well as achieve other important economic development and social goals. Ocean energy has potential as a predictable, renewable energy source that could help to reduce GHG emissions, mitigate risks associated with fossil fuel price volatility, and provide long-term energy security. Additional potential benefits include creating jobs and other significant economic development opportunities as well as improving public health from reduced emissions. While ocean energy has a great deal of potential, it is still in the development phase and not yet competitive with more mature renewable energy technologies such as wind. Further research and development is required and critical barriers need to be addressed, from permitting to grid-connectivity, in order to leverage its potential to be a highly predictable source of energy relative to other renewable generation assets.

In 2012, Washington State's electric utility fuel mix comprised of about four percent of non-hydro renewable energy sources, with about 3.32 percent of wind, 0.34 percent of biomass and 0.33 percent of waste.⁴⁷³ Meanwhile, coal accounted for 13.4 percent of the electric utilities' fuel mix and 79.3% of carbon emissions.⁴⁷⁴ Investing in ocean energy technologies could position Washington to phase out less desirable, carbon intensive electricity generation energy sources, such as coal-fired power plants. The IPCC found that ocean energy has the potential to deliver long-term carbon emissions reductions as ocean energy technologies do not generate GHGs during operation and have low lifecycle GHG emissions. GHG emissions may arise from different aspects over the lifecycle of an ocean energy system, however, including raw material extraction, component manufacturing, construction, maintenance and decommissioning. The IPCC estimates lifecycle GHG emissions from wave and tidal energy systems to be are less than 23g CO₂e/kWh, with a median estimate of lifecycle GHG emissions of around 8g CO₂e/kWh for wave energy.⁴⁷⁵ Utility-scale deployments with transmission grid connections can be used to displace carbon-emitting energy supplies.

⁴⁷² <http://pnwer.org/Portals/26/Sen%20Roblan%20-%20Principle%20Power%20and%20the%20Wind%20Float%20Pacific%20Project.pdf>

⁴⁷³ State of Washington Department of Commerce. *Washington State Electric Utility Fuel Mix Disclosure Reports for Calendar Year 2012*. July 2013. Report accessed August 2013 at <http://www.commerce.wa.gov/Documents/Utility-Fuel-Mix-Reports-Data-CY2012.pdf>

⁴⁷⁴ State of Washington Department of Commerce. *Washington State Electric Utility Fuel Mix Disclosure Reports for Calendar Year 2012*. July 2013.

⁴⁷⁵ Lewis, A., et al, 2011: *Ocean Energy*. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Although ocean energy technologies are at an early stage of development, there are encouraging signs that the investment cost of technologies and the levelized cost of electricity generated will decline from their present non-competitive levels as R&D and demonstrations proceed, and as deployment occurs.⁴⁷⁶ A 2013 DOE shows that for a range of existing technologies and devices and considering basic technical and economic factors, there are many areas potentially suitable for marine renewable energy development off the Washington coast.⁴⁷⁷

The DOE finds that there is a vast amount of energy available in ocean waves and tides, with high tidal resources in the Puget Sound, WA, and that a cost-effective marine and hydrokinetic (MHK) industry could provide a substantial amount of electricity from highly predictable waves and currents to the nation. Moreover, the DOE Water Power Program finds that the newly emerging MHK industry holds tremendous potential for job growth as MHK technologies progress towards commercial readiness.⁴⁷⁸ Navigant Consulting estimated about 14 full time employees per MW generated directly from the ocean wave or tidal energy market.⁴⁷⁹ In addition, as the ocean energy market grows, it could also provide opportunities in related and supporting industries. Supply chain opportunities range from design, fabrication, component supply and assembly to site surveys, installation, commissioning and testing, performance assessment, environmental assessment and monitoring, and servicing and maintenance. The European Commission estimates that marine energy has the potential to generate 10 to 12 jobs per MW in the EU-27. As the ocean energy market grows, it could also provide opportunities in related and supporting industries. Supply chain opportunities range from design, fabrication, component supply and assembly to site surveys, installation, commissioning and testing, performance assessment, environmental assessment and monitoring and servicing and maintenance.

While there are many opportunities in the Pacific Northwest for developing ocean energy, ocean energy technology is relatively new and still in the development phase and there is significant uncertainty regarding when wave, tidal, and other ocean energy technologies will be producing grid-connected energy. Furthermore, multiple barriers exist for ocean energy technologies, such

⁴⁷⁶ Lewis, A., et al, 2011: *Ocean Energy*. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

⁴⁷⁷ DOE. *Geospatial Analysis of Technical and Economic Suitability for Renewable Ocean Energy Development on Washington's Outer Coast*. (June 2013). Accessed September 2013 at http://www.msp.wa.gov/wp-content/uploads/2013/07/PNNL_EnergySuitability_Final-Report.pdf

⁴⁷⁸ US DOE EERE Water Power Program. *Water Power for a Clean Energy Future*. (April 2013). Accessed August 2013 at: http://www1.eere.energy.gov/water/pdfs/wp_accomplishments_brochure.pdf

⁴⁷⁹ Navigant Consulting. *Job Creation Opportunities in Hydropower: Final Report*. (Powerpoint Presentation). (September 20, 2009). Accessed August 2013 at: http://www.hydro.org/wp-content/uploads/2010/12/NHA_JobsStudy_FinalReport.pdf

as gaining site permits, the environmental impact of technology deployments, and grid connectivity for transmitting the energy produced.⁴⁸⁰

Permitting and obtaining Federal approval to install ocean energy projects can be cumbersome and is one of the key factors delaying the deployment of ocean energy.⁴⁸¹ Progress has been made to allow the pilot testing of new technologies on a smaller scale before going through the full permitting process.⁴⁸² In 2010, legislation passed by the Washington Legislature provided a framework for coastal and marine spatial planning (CMSP).⁴⁸³ Nonetheless, marine technologies are new, unproven, and their cumulative environmental impacts are not known. Though ocean energy systems are expected to have little negative impact on the environment, the technologies are too new to gauge all factors. Testing and design tools should be developed and validated to help accelerate development and successful deployment. Design requirements and guidelines would help expedite ocean energy technologies to viable commercial designs. Moreover, resource assessments for ocean energy are currently incomplete and have high uncertainty.⁴⁸⁴ A method for reporting the resource quantities for comparison with standard energy metrics is still not well developed. Ocean energy resources need to be quantified in terms of raw resources and extractable electric resources. Guidelines must be developed to make this potential consistent with other renewable energies.

Many research, development, test and evaluation activities are underway in Washington and Oregon and others have yet to be planned. Prior to commercialization, effectively engaging and collaborating with key stakeholders, such as in the crabbing and fishing industry, will be key to minimize conflicts as will the development of enabling technologies (such as anchors, moorings, wave energy converters) to reduce conflict with key stakeholders and existing users, and recognizing limitations in available installation equipment. A 2013 DOE study concluded that marine renewable energy as a potential new use of ocean space and resources in Washington is viewed favorable by some as a local, renewable energy source offering new opportunities for employment, economic development in coastal communities, increased energy independence, and a role for the state in a new and innovative industry while others are concerned that marine renewable energy could displace traditional ocean activities or negatively impact the marine environment, coastal recreation, ocean views, or the electricity grid.⁴⁸⁵ Furthermore, as the availability of transmission lines will impact the rate at which ocean energy can be

⁴⁸⁰ US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009). Accessed August 2013 at <https://www1.eere.energy.gov/femp/pdfs/44200.pdf>

⁴⁸¹ US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009).

⁴⁸² US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009).

⁴⁸³ http://ctwsound.com/wp-content/uploads/2012/07/WSOEC_SummaryofSpeakersRemarks_2011.pdf

⁴⁸⁴ US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009).

⁴⁸⁵ DOE. *Geospatial Analysis of Technical and Economic Suitability for Renewable Ocean Energy Development on Washington's Outer Coast*. (June 2013).

commercialized, planning for upgrades with utility companies should be integrated in overall ocean energy projects.

Designing and developing policies to support the commercialization of ocean energy in Washington could help enhance and accelerate the deployment of ocean energy sources while also supporting other policy goals, such as GHG reduction and creation of clean energy jobs. Designing a policy compatible with existing policies and economic goals will be critical for policy efficacy and success.

DRAFT

15 Landfill Methane Capture

Table 66: Potential Costs and Benefits and Additional Screening Criteria for Implementation of a Landfill Methane Capture Policy to Washington Consumers and Businesses

Potential Action for Consideration	
<ul style="list-style-type: none"> Consider implementing a Landfill Methane Capture policy similar to California's. Under California regulation, landfills with greater than 450,000 tons of waste-in-place, a landfill gas heat rate greater than or equal to 3.0 MMBtu per hour, and which received waste after January 1, 1977 must install and operate a landfill GCCS with 99 percent destruction removal efficiency for methane. Hazardous waste landfills, construction and demolition landfills, and landfills regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) are exempt.⁴⁸⁶ 	
Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
<ul style="list-style-type: none"> \$0.09 per month per Californian Reduction in NMOC emissions 	<ul style="list-style-type: none"> Estimated capital investment of over \$27 million to design, construct, and install required landfill GCCS, and an additional \$6.4-\$14 million annually in recurring costs. Total costs for technology, operation, monitoring and maintenance are estimated at approximately \$335 million. Costs to landfill operators may translate into jobs in related sectors.
Summary of Screening Criteria	
<p><i>Does the policy target an emissions source of significant magnitude in Washington?</i></p> <p>Solid waste management resulted in 2.1 MMTCO₂e of emissions in Washington in 2010, or 2 percent of the States total GHG emissions in that year. This has grown from 1.0 MMTCO₂e in 1990, or about 1 percent of the State's total emissions in that year.</p> <p><i>What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?</i></p> <p>At this time, California is the only state in the U.S. that has implemented a landfill methane policy more stringent than the federal rules, and program evaluation data on emissions reductions and costs are unavailable.</p> <p>In general, the Landfill Methane Control Measure represents a relatively low cost means of reducing CH₄ emissions according to California modeling. However, several parties commented during the public comment period that the ARB estimates were lower than many individual landfills would experience. For smaller landfills, the costs to mitigate CH₄ will be greater on a per mtCO₂e basis.</p> <p><i>Is the policy discrete and comprehensive, or is it instead a bundle of related policies?</i></p> <p>The policy is discrete and comprehensive, as it would be a state-level regulation over landfills of a certain size or design.</p> <p><i>Can the policy be meaningfully implemented or influenced at the State level?</i></p>	

⁴⁸⁶ California Air Resources Board. *Implementation Guidance Document for the Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. July 2011. Accessed August 2013 at: <http://www.arb.ca.gov/cc/landfills/docs/guidance0711.pdf>

Yes. The policy would be implemented at the state level.

15.1 Introduction

The anaerobic degradation of organic waste creates methane (CH₄), a potent GHG that is 21 times more heat trapping than carbon dioxide. Modern municipal solid waste (MSW) landfills are managed anaerobically (in the absence of oxygen), and emit CH₄ emissions over time, in varying amounts depending on landfill management practices. Typically, CH₄ comprises approximately 50 percent of landfill gas (LFG). In the U.S., landfills account for 17.5 percent of all CH₄ emissions, or about 1.8 percent of total GHG emissions.⁴⁸⁷

Federally, the New Source Performance Standard (NSPS) regulates large MSW landfills, and requires those with greater than 50 megagrams (Mg) emissions per year of non-methane organic compounds (NMOC) to install gas collection and control systems (GCCS). Although these systems are implemented for the management of NMOC, the management practice of combusting LFG also destroys the CH₄ component of the gas. Landfill GCCS capture and combust CH₄ generated at landfills, preventing it from being released to the atmosphere, or capture it for energy use if it is generated in large enough amounts.

The NSPS applies only to landfills with a design capacity of 2.5 million metric tons or greater.⁴⁸⁸ However, many landfills in the U.S. are smaller than this, and there is no federal standard requiring GCCS at those sites. California implemented a Landfill Methane Control Measure as part of their AB 32 Global Warming Solutions Act to target smaller landfills that still have significant CH₄ emissions.

California Landfill Methane Control Measure: Under California regulation, landfills with greater than 450,000 tons of waste-in-place, a landfill gas heat rate greater than or equal to 3.0 MMBtu per hour, and which received waste after January 1, 1977 must install and operate a landfill GCCS with 99 percent destruction removal efficiency for methane. Hazardous waste landfills, construction and demolition landfills, and landfills regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) are exempt.⁴⁸⁹ At this time, California is the only state in the U.S. that has implemented a landfill methane policy more

⁴⁸⁷ U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011*. April 12, 2013. Accessed August 2013 at: <http://epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf>

⁴⁸⁸ U.S. Environmental Protection Agency. *Rule and Implementation Information for Standards of Performance for Municipal Solid Waste Landfills*. Accessed July 2013 at: <http://www.epa.gov/ttnatw01/landfill/landflpg.html>

⁴⁸⁹ California Air Resources Board. *Implementation Guidance Document for the Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. July 2011. Accessed August 2013 at: <http://www.arb.ca.gov/cc/landfills/docs/guidance0711.pdf>

stringent than the federal rules, and program evaluation data on emissions reductions and costs are unavailable.

In general, the Landfill Methane Control Measure represents a relatively low cost means of reducing CH₄ emissions according to California modeling. However, several parties commented during the public comment period that the ARB estimates were lower than many individual landfills would experience. For smaller landfills, the costs to mitigate CH₄ will be greater on a per mtCO₂e basis.

During policy development, the California ARB quantified costs and benefits of the Landfill Methane Control Measure for two sectors of the economy: landfill operators and regulators. The total costs to affected businesses are approximately \$111 million. These costs include site monitoring, system installation, operation and maintenance, and reporting, much of which must be conducted on-site or in-state. The annual costs to the government for implementation and compliance monitoring is estimated to range from \$24,500 to \$1.2 million.⁴⁹⁰

Over the life of the measure, the ARB calculated that the Landfill Methane Control Measure would cost the average California household \$0.09 per month.⁴⁹¹ This cost would not be expected to significantly impact household consumption and spending.

As noted, the federal NSPS regulation requiring landfill GCCS at large gassy landfills was not developed to manage CH₄. Rather, it targets volatile organic compounds (VOCs) and NMOCs which are harmful to air quality and present health concerns. However, the technology for mitigating these compounds – combustion – also destroys the methane contained in LFG. For landfills regulated under NSPS, the destruction and management of methane could thus be considered a co-benefit. Conversely, a policy that targets methane for destruction will have the co-benefit of mitigating VOCs and NMOCs.⁴⁹²

15.2 Literature Review of Washington Potential

Landfills that accepted MSW on or after January 1, 1980 and generate methane in amounts equivalent to 25,000 metric tons of CO₂e or more per year are required to report to EPA under the Greenhouse Gas Reporting Program. EPA's definition of an MSW landfill includes the landfill, LFG collection systems, and destruction devices for LFGs (including flares). Since there are no notable studies on the potential of a Landfill Methane Capture policy similar to California's in Washington, a broad, high-level analysis was conducted to understand the potential magnitude of impact of such a policy in Washington.

⁴⁹⁰ Ibid.

⁴⁹¹ Ibid.

⁴⁹² Ibid.

In 2011, 23 facilities in Washington reported 1.4 MMTCO₂e of emissions and in California, 118 facilities reported 7.5 MMTCO₂e.⁴⁹³ Assuming that the same percentage of facilities in Washington and California were below the reporting threshold (and therefore did not report to the GHGRP), the 2011 ratio of Washington emissions from reporting landfills to California emissions from reporting landfills was used to calculate expected costs to Washington (about 18.6 percent). Using this ratio and the cost and emission reduction data detailed in Appendix A, the following high-level estimates of potential impacts in Washington were calculated:

Total costs over a 23 year time frame would be at \$20.72 million (2008 USD). The overall cost-effectiveness estimates inclusive of private and public costs of the measure range from a low of \$5.50 per mtCO₂e to a high of \$11.38 per mtCO₂e over the measure's expected life, with an average of \$8.64 per mtCO₂e.⁴⁹⁴

California ARB estimates, scaled to Washington, would result in the following costs to affected businesses over the life of the measure:

- Capital: \$1.5 million
- Annual Operations and Maintenance (O&M): \$8 million
- Monitoring: \$11.2 million
- Reporting: \$10,117
- TOTAL: \$20.72 million

Additionally, California ARB estimates, scaled to Washington, would result in the following costs to affected government agencies which manage landfills:

- Capital: \$3.5 million
- Annual O&M: \$19.6 million
- Monitoring: \$18.9 million
- Reporting: \$46,667
- TOTAL: \$42 million

Based on scaled California data, annual emission reductions in Washington may range from a low of 0.2 MMTCO₂e in the first year of implementation to an estimated high of 0.4 MMTCO₂e

⁴⁹³ EPA. Facility Level Information on Greenhouse Gas Tool. Accessed September 2013 at: <http://ghgdata.epa.gov/ghgp/main.do>

⁴⁹⁴ California Air Resources Board. *Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. May 2009. Accessed August 2013 at: <http://www.arb.ca.gov/regact/2009/landfills09/isor.pdf>

in the final year. California The cumulative emission reductions resulting from the measure would be 7.2 MMTCO₂e over 23 years.⁴⁹⁵

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⁴⁹⁵ California Air Resources Board. May 2009.

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